

Arizona Cliffrose

(*Purshia subintegra*)

Recovery Plan



ARIZONA CLIFFROSE (Purshia subintegra)

RECOVERY PLAN

Prepared by:

**Susan Rutman
U.S. Fish and Wildlife Service
Arizona Ecological Services State Office
Phoenix, Arizona**

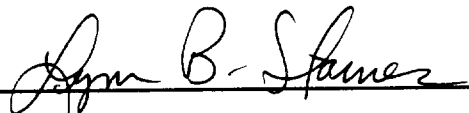
**Dr. Barbara G. Phillips
Coconino National Forest
Flagstaff, Arizona**

**Dr. Arthur M. Phillips, III
Flagstaff, Arizona**

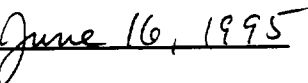
Prepared for:

**Region 2
U.S. Fish and Wildlife Service
Albuquerque, New Mexico**

Approved:



Date:



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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1994. Arizona Cliffrose (*Purshia subintegra*) Recovery Plan. USDI Fish and Wildlife Service, Arizona Ecological Services State Office, Phoenix, Arizona. 90 pp. + appendix.

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EXECUTIVE SUMMARY

Current Status: Four disjunct populations of Arizona cliffrose, listed as endangered in 1984, exist along a 322 kilometer (km) (200 mile) wide area of central Arizona. The number of plants in each population is unquantified.

Habitat Requirements and Limiting Factors: Arizona cliffrose occurs in the Sonoran desertscrub where the winters are mild, summers are hot, and the 22.9-86 centimeters (cm) (9-34 inches) of rainfall is evenly distributed between summer and winter rainfall periods. The species occurs only on limestone formed from Tertiary lakebed deposits. Threats include livestock and burro grazing, poor reproduction, mineral exploration and development, construction and maintenance of roads and utility corridors, recreation, off-road vehicle (ORV) use, urbanization, pesticides, and inundation.

Recovery Objective: Reclassification to threatened.

Recovery Criteria: Maintenance of four viable populations, protection of sufficient quantity and quality of habitat needed to support viable populations, regulatory mechanisms or written land management commitments that provide for long-term protection, and determination that the species no longer is endangered.

Actions Needed:

1. Produce management plans for four recovery units.
2. Conduct research needed to guide recovery efforts.
3. Eliminate or minimize threats.
4. Enforce and apply existing laws and regulations.
5. Inform and educate.

Costs (Thousands of dollars):

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5</u>	<u>Row Total</u>
1994	35.0	179.0	74.0	23.0	1.0	307.0
1995	33.5	139.0	29.5	53.0	1.0	256.0
1996	0	106.0	25.5	3.0	1.0	135.5
1997	0	74.0	17.0	3.0	1.0	95.0
1998	0	74.0	17.0	3.0	1.0	95.0
1999	0	74.0	17.0	3.0	1.0	95.0
2000	0	74.0	17.0	3.0	1.0	95.0
2001	0	74.0	17.0	3.0	1.0	95.0
2002	0	74.0	17.0	3.0	1.0	95.0
2003-2008	0	449.0	102.0	18.0	6.0	570.0
<u>Recovery Cost</u>	68.5	1312.0	333.0	115.0	15.0	1843.5

Date of Recovery: If continuous progress is made, downlisting may be possible by 2008.

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PART I - INTRODUCTION

Brief Overview

The U.S. Fish and Wildlife Service (Service) added *Purshia subintegra* (Kearney) Henrickson (Arizona cliffrose) to the endangered species list on May 29, 1984 (U.S. Fish and Wildlife Service 1984). The scientific name of the species was then *Cowania subintegra*. Arizona cliffrose is known from four disjunct populations on the northern edge of the Sonoran Desert (Figure 1). These populations occur along the sub-Mogollon region of central Arizona over a distance of 200 miles. For thirty years the species was only known from the type locality near Burro Creek, Mohave County. In September 1968, a second population was discovered near Bylas, Graham County (Pinkava *et al.* 1970). In 1984 and 1985 two additional population areas were discovered near Cottonwood, Yavapai County, and near Horseshoe Lake, Maricopa and Yavapai Counties.

Arizona cliffrose is a rare Arizona edaphic endemic, restricted to nutrient deficient calcareous soils (Anderson 1986, Anderson 1993). The disjunct distribution of this species is unique. No other plant species occurs only in the same four sites as Arizona cliffrose.

Each population of Arizona cliffrose has unique biological/ecological characteristics and threats. Threats to the species include livestock, and burro grazing, mineral exploration and development, construction and maintenance of roads and utility rights-of-way, recreation, poor reproduction, off-road vehicle (ORV) use, urbanization, pesticides, and inundation. The relative importance of each of these threats varies from population to population. This recovery plan will treat each population as an individual recovery unit necessary for the survival and recovery of the species and address threats specific to those populations.

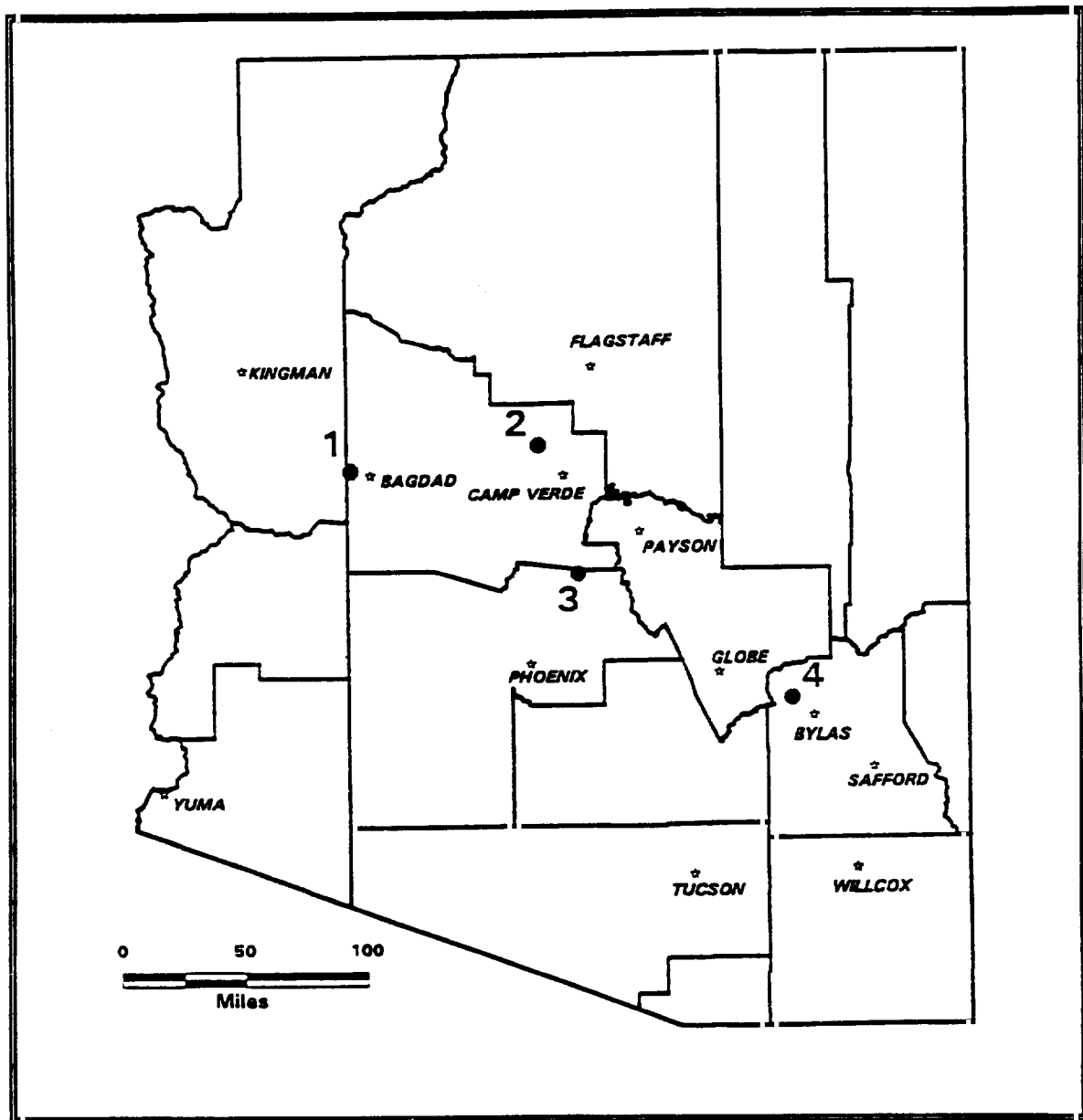


Figure 1. Map of Arizona showing location of Arizona cliffrose populations. 1 = Burro Creek; 2 = Cottonwood; 3 = Horseshoe Lake; and 4 = Bylas.

Description

The following description of *P. subintegra* represents a composite of the original description (Kearney 1943), recent field and taxonomic work, combined with an understanding of its ecology and hypothesized evolutionary history. *P. subintegra* has certain definitive characteristics that separate it from other *Purshia* species. However, individual variation in leaf size and shape, glandularity, and other characters may occur. In this way, *P. subintegra* is no different from many other plant species that display some amount of genotypic and phenotypic variability.

Arizona cliffrose is a member of the Rose Family (Rosaceae). It is a low, straggling woody perennial usually 1 - 2 meters (m) (3 - 6 feet) high and generally wider than tall. In the Cottonwood population, plants can reach a maximum of 2.4 m (8 feet) tall and 3.7 m (12 feet) in diameter. The horizontal lower branches are spreading, and the central branches are irregularly ascending (Denham and Fobes 1992b). New shoots tend to be red-brown and pubescent with a red dot below the fascicle. The older branches have light gray bark that becomes shreddy. The herbage is not viscid (sticky), although some resin glands may be present, causing slight stickiness.

The shape of *Purshia subintegra* leaves is variable. The leaves are very narrow and short: averaging about 8 millimeters (mm) (0.3 inch) long (Denham and Fobes 1992b) and 3 mm (0.1 inch) wide. Leaves usually have no lobes, but occasionally have 1 or 2 rounded, shallow lobes or teeth just below the leaf tip (Figure 2 and 3A). The margins (edges) of the leaves are curled towards the underside (revolute). The upper leaf surface is bright or dark green and usually has no punctate glands. The upper leaf surface is usually loosely arachnoid-pubescent (having a few long hairs) on the upper surface (Figure 3A), but

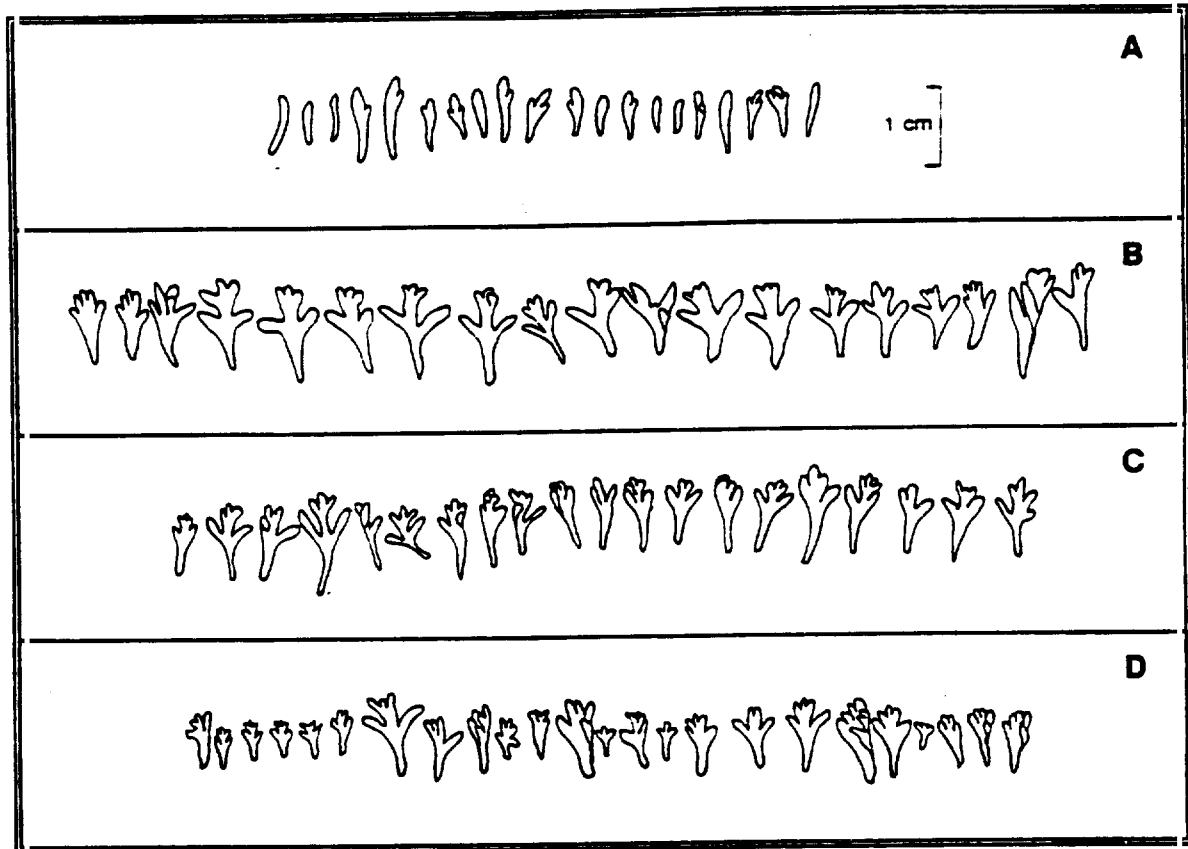


Figure 2. Leaf shapes of a typical *Purshia subintegra* (A), a representative Tonto Basin form of *P. stansburiana* (B), a representative Verde Valley form of *P. stansburiana* (C), and a standard form *P. stansburiana* (D) (Reichenbacher 1993).

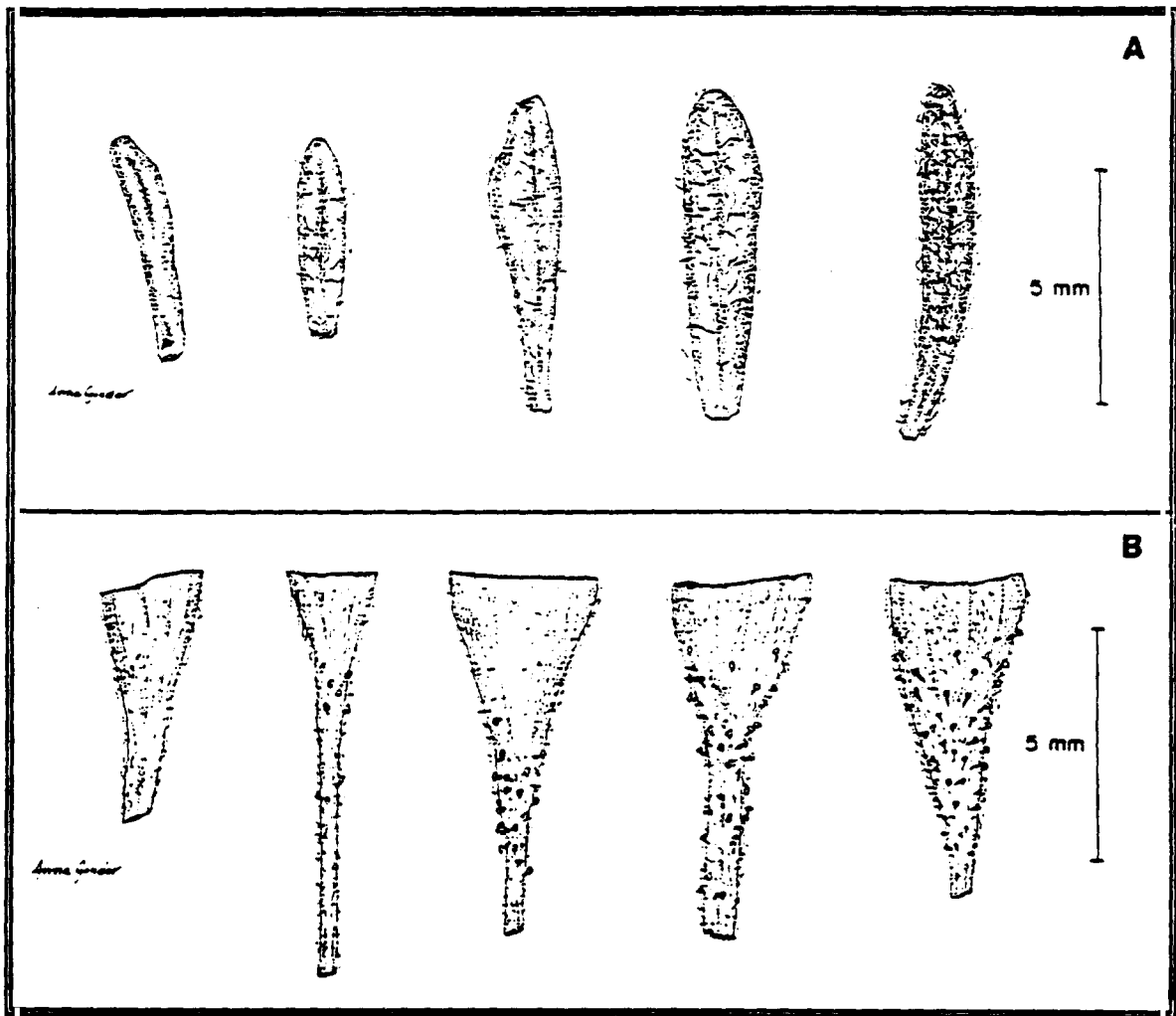


Figure 3. (A) *Purshia subintegra* leaves showing variability in pubescence of upper leaf surface. (B) Representative *Purshia subintegra* hypanthia, including peduncles (flower stalks) (Reichenbacher 1993).

sometimes it is hairless. The lower surface is densely white-lanate (wooly) and usually has no punctate glands.

Each flower is born on a single stalk (peduncle). The end of the peduncle gradually merges with the beginning of the narrowly funnelform hypanthium, the flower part bearing the sepals, petals, and stamens. The average length of the hypanthium plus peduncle is 5.1 mm (< 0.3 inch) (Reichenbacher 1993). The hypanthium has no stipitate (stalked) glands or has few glands. The typical flower has 3 - 7 pistils and 5 white or pale yellow petals that are about 10 mm (0.4 inch) long, slightly smaller than *P. stansburiana* flowers. Occasionally, flowers have 8 - 12 petals per flower (Denham and Fobes 1992a). As the achenes (fruits) develop, the style remains attached and forms a short, white, feathery plume.

It is usually easy to distinguish *Purshia subintegra* from *P. stansburiana*. In contrast to *P. subintegra*, *P. stansburiana* is a tall, erect shrub up to 7.6 m (25 feet), with numerous punctate glands on all leaves and numerous stipitate glands on new growth and hypanthia (Figure 3B) (Denham and Fobes 1992e). These glands secrete copious amounts of sticky, strong-smelling fluid, imparting a distinctive odor and touch to the plants. Some forms of *P. stansburiana* have no glands on the leaves. The hairless leaves have 3 - 5 deep lobes and tend to be folded along the midvein (conduplicate). New growth of branches tends to be bright red. For a comparison of some of the morphological characters of *P. subintegra* and *P. stansburiana*, see Table 1.

The genus *Purshia* contains seven extant species, including five recently transferred from *Cowania* by Henrickson (1986). These species range from central Mexico to western Colorado, northern Utah, and eastern California

Group	Punctate, Resinous Leaf Glands	Number of Leaf Lobes	Hypanthium Length (average)	Geographic Locality
<u>Purshia subintegra</u>	Absent or few	Usually no lobes, sometimes 1-2	5.1 mm	Burro Creek, Verde Valley, Horseshoe Lake, Bylas
<u>Purshia stansburiana</u> (Verde Valley form)	Usually present	3-5 lobes	9.2 mm	Verde Valley
<u>Purshia stansburiana</u> (Tonto Basin form)	Usually absent	3-5 lobes	10.1 mm	Tonto Basin & various
<u>Purshia stansburiana</u> (common form)	Present	3-5 lobes	6.6 mm	Southwestern U.S.

Table 1. Comparison of distinguishing characters of *Purshia subintegra*, *P. stansburiana*, and *P. stansburiana* in the Verde Valley and Tonto Basin. Hypanthium length was measured as the length of the peduncle plus the length of the hypanthium (Reichenbacher 1993).

(Anderson 1986). The chromosome counts of all *Purshia* species are $n = 9$, one of the base numbers of the Rosaceae (McArthur *et al.* 1983, Baker *et al.* 1984, McArthur and Sanderson 1985).

Plants of the genus *Purshia* tend to be phenotypically plastic and can respond to long-term and seasonal changes in climate by producing leaves and shoots that have adapted to local or seasonal climatic conditions. This plasticity can explain some puzzling differences in leaf or shoot forms found on the same plant or on different plants within the same population. In particular, seedlings and plant growth that occurs during or after above-average rainfall may exhibit variable growth forms.

Taxonomy and Evolutionary History

From the time of its original description, the variability of *Purshia subintegra* and its similarities with *P. stansburiana* has been acknowledged. The specific epithet *subintegra* translates loosely as "leaf margins not quite entire." In the type description of *P. subintegra*, Kearney (1943) noted that Arizona cliffrose flowers and fruit "apparently present no characters that are not within the range of variation" of *P. stansburiana*. However, he distinguished the two species by noting that *P. stansburiana* is larger and more erect, with branchlets more stiffly ascending, bark reddish brown or dark grey, the herbage usually very viscid (sticky), and pedicels (flower stalk) and hypanthium usually with stipitate (stalked) glands. He also noted that *P. stansburiana* has much larger leaves that are lobed and nearly always conspicuously punctate (dotted with pitted glands). *P. stansburiana* is a common plant occurring in the mid- to upper-elevation habitats throughout much of Arizona and usually can be clearly differentiated from *P. subintegra*.

The variability of *Purshia subintegra* and *P. stansburiana* sometimes makes it difficult to classify individual plants. This difficulty has interfered with accurately estimating the number of populations and number of plants. Differing interpretations of *P. subintegra* have tended to focus on a few morphological traits: leaf lobing, leaf glandularity, and hypanthium glandularity. *Purshia* populations on white Tertiary-age limestone deposits located at Burro Creek and Bylas have been included by most experts within the definition of *P. subintegra*. However, some people have found some plants in the Verde Valley, Tonto Basin, and a few other areas difficult to classify. Several authors have noted that variability in *P. subintegra* may be the result of hybridization with *P. stansburiana* (Reichenbacher 1986, Phillips *et al.* 1988, Schaak and Morefield 1985, Schaak 1987a, Warrick 1986, Phillips *et al.* 1987, Boucher and Goodwin 1984).

Questions about the hybrid status of *Purshia subintegra* were formalized in two publications (Schaak 1987a, Schaak 1987b). After an examination of *P. subintegra* specimens, Schaak (1987b) determined that ". . . if the variability displayed on the type preparations and observed in central Arizona populations of *P. subintegra* can be attributed to gene exchange between . . . *P. stansburiana* and an unnamed central Arizona *Purshia*, *P. subintegra* will be given hybrid status and the other putative parent, presently included within *P. subintegra*, will be given specific recognition." In a later publication, Schaak (1987a) decided that the type specimens of *P. subintegra* did represent material of hybrid origin. They contained glandular leaves, glandular hypanthia, and lobed leaves, which he believed were characteristics outside the original description of *P. subintegra*. Based on this definition of the species and his belief that the type specimen was a hybrid, he rejected Kearney's concept of the species, and applied the new name *P. pinkavae* to the *Purshia* plants northwest of Bylas, Graham County. Schaak believed the *Purshia* plants at Burro Creek, Horseshoe Lake, and

Cottonwood were formed via past hybridization between *P. stansburiana* and *P. pinkavae*.

Schaak's interpretation of *P. pinkavae* (Schaak 1987a) was narrowly defined and not widely accepted by the botanical community. His description was more narrowly defined than the type description of *P. subintegra*, which allowed for variability in leaf lobing. More recently, botanists familiar with the species generally agree that *P. subintegra* and *P. stansburiana* are distinct, but a more refined definition of *P. subintegra* would be helpful.

Recent studies have applied objective scientific techniques to resolve these taxonomic questions. Using horizontal starch gel electrophoretic techniques, Phillips *et al.* (1988) examined genetic variation of *P. subintegra* and *P. stansburiana* at 14 loci coding for soluble enzymes. These analyses were inconclusive because although no differences were found for the loci they tested, not all loci were tested.

Reichenbacher (1988) conducted a morphometric analysis of plants from the four known populations of *P. subintegra* and plants that were difficult to assign to either taxa ("unknowns"). This study was later expanded to include more plants of *P. subintegra* and "unknowns" and also included plants representing *P. stansburiana* from several areas around the state (Reichenbacher 1993). His discriminant function and principal component analyses concluded that the Bylas, Burro Creek, Horseshoe Lake, and Cottonwood populations of *Purshia* were *P. subintegra*, containing variability normal for a species with widely disjunct populations. He also found that certain populations, notably in the Verde Valley and Tonto Basin, contained some characters typical of *P. subintegra* and some typical of *P. stansburiana*.

Mount and Logan (1993) analyzed DNA from the same pressed plant specimens that Reichenbacher measured for the morphometric analysis. He used the random-amplified-polymorphic-DNA (RAPD) marker technique to study genetic variability in these *Purshia* plants. He combined his DNA analysis with Reichenbacher's morphometric data (Reichenbacher 1993) and produced results that support the hypothesis that *P. subintegra* and *P. stansburiana* may have had an evolutionary history that could explain the morphologic variability. Mount and Logan's (1993) findings supported Reichenbacher's (1993) hypothesis that the Burro Creek, Bylas, Horseshoe Lake, and Cottonwood populations are *P. subintegra*, but that in the past gene exchange may have occurred between *P. subintegra* and *P. stansburiana* in the Verde Valley and Tonto Basin, resulting in plants that are difficult to classify.

Evolutionary History

Several botanists have hypothesized that *Purshia subintegra* is a Pleistocene relict (McCarten *in litt.* 1979, Van Devender 1980, Phillips *et al.* 1980, J. Henrickson, California State University, pers. comm., 1992). Anderson (1986, 1993) concluded that the ecological and biogeographic characteristics of *P. subintegra* are typical of a Pleistocene relict. *P. subintegra* occurs within a narrow geographic area in Arizona, where seasonal temperature variation and biseasonal rainfall are similar to the Pleistocene climate (Anderson 1993).

Gaining general acceptance among the botanical community is a hypothesis that explains the distribution of *Purshia subintegra* and morphologic variability of some *Purshia* populations (Henrickson *in litt.* 1993, Anderson 1993, Reichenbacher 1993, Mount and Logan 1993). Hypothetically, *P. subintegra* was endemic to small areas of uncommon limestone soils in central Arizona thousands of years ago following the last glacial period. The wetter glacial periods of the Pleistocene favored the range expansion of *P. stansburiana* southward from

northern Arizona into the present day desert areas of southern Arizona. During this period, these two *Purshia* species came in contact in some areas in central Arizona. During their contact, the two species hybridized or introgressed in certain areas. With the retreat of Stansbury cliffrose northward during the present interglacial, introgressed populations, such as Tonto Basin, may exist where the parents no longer do. The first-generation hybrids interbred for many generations to form hybrid swarms in the Verde Valley or Tonto Basin that may now be introgressing (exchanging genes), mostly with *P. subintegra*.

The Service considers the plants in these introgressing hybrid swarms to be outside the definition of *Purshia subintegra*. These plants will tentatively be referred to as forms of *P. stansburiana*, recognizing that they differ somewhat from 'classical' *P. stansburiana*. Plants in these populations may contain genes from both *P. subintegra* and *P. stansburiana*. Each hybrid swarm has a unique amount of variability related to the expression of mixed genes from past hybridization events and current introgression, and/or the degree of introgression being expressed by surviving plants after selection allows survival of certain phenotypes (Henrickson *in litt.* 1993).

Even though each hybrid swarm may be unique, Reichenbacher's (1993) morphometric analysis was able to distinguish two separate, general forms: one group of small populations in the Verde Valley and another group of small populations in the Tonto Basin and elsewhere in central Arizona, including the Verde Valley. The distinguishing features of *P. subintegra*, *P. stansburiana*, and the two general types of hybrid swarms are presented in Table 1.

If the Tonto Basin and Verde Valley populations of *Purshia* (excluding the Cottonwood *P. subintegra* population) are hybrid swarms, they illustrate the migratory and dynamic nature of evolving plant populations. Plants in the hybrid

swarms are genetically and phenotypically variable, represent a piece of the evolutionary history of *Purshia*, and may provide the key to the future of the genus and species. For these reasons, conservation of these hybrid swarms is important. If the Tonto Basin and Verde Valley forms are described as distinct taxa in the future, the Service may consider providing protection under the Endangered Species Act. For those plants not within *Purshia subintegra*, other conservation strategies should be pursued.

Range and Distribution

The four known populations of *Purshia subintegra* are spread across a 200-mile zone of central Arizona. The disjunct distribution pattern is likely the result of the infrequent overlap of infertile limestone soils in areas with current climatic conditions similar to the Pleistocene (Anderson 1993). Arizona cliffrose grows on gentle to steep slopes, open basins, and limestone ledges and outcrops. The landscape is dissected by ephemeral drainages and is sparsely vegetated.

Maps (figures 4-7) illustrating the locations of known populations follow the text of the Range and Distribution section of the text.

The longest-known population of Arizona cliffrose is the Burro Creek population in Mohave and Yavapai Counties. R. A. Darrow and Crooks first collected the species on April 20, 1938, in the foothills of the Aquarius Mountains two miles west of Burro Creek Crossing on the road from Wikieup to Hillside, southeastern Mohave County near the Yavapai County line. Three years later, the type specimen was collected by Darrow and L. Benson on April 18, 1941 (Kearney 1943). The largest subpopulation of Arizona cliffrose in the Burro Creek vicinity is located in Township 14 North, Range 11 West, sections 1, 2,

11, and 12, Mohave County (Figure 4). A small, outlier subpopulation in Township 14 North, Range 11 West, sections 20, 21, 28, and 29, Mohave County, was found by J.L. Anderson in 1991. In 1993, M. Baker found another subpopulation in Township 14 North, Range 11 West, sections 31 and 32, Yavapai County (R. Peck and R. Hall, BLM- Kingman Resource Area, pers. comm., 1993). The elevation of the three subpopulations ranges from 762 - 884 m (2,500 - 2,900 feet).

Nearly 30 years after the type specimen was collected, Pinkava, Lehto and Keil (1970) discovered a second population of the species twelve miles northwest of Bylas in Graham County, Township 2 South, Range 20 East, sections 23, 24, 25, and 26 (Figure 5). The full extent of this population is unknown, due to limited surveys. The elevation range of this population is 823 - 884 m (2,700 - 2,900 feet).

On March 16, 1984, J.L. Anderson found a third locality (Anderson 1986) at the north end of the Verde Valley in the vicinity of Dead Horse Ranch State Park near Cottonwood, Yavapai County (Figure 6). On May 10, 1984, N.B. Herkenham independently found this third population of the species during a botanical inventory of Dead Horse Ranch State Park. This population is located about halfway between the Bylas and Burro Creek populations at Township 16 North, Range 3 East, sections 22-27, 35, 36, and Township 15 North, Range 3 East, section 1. At 1,000 -1,103 m (3,280 - 3,620 feet), this population has the highest altitude of all Arizona cliffrose populations.

In August 1985, B.G. Phillips discovered a fourth population near Horseshoe Lake, Maricopa County (Figure 7), during a search for *Eriogonum ripleyi* J.T. Howell,

another rare species of calcareous soils. The subpopulation she discovered is located west-southwest of Horseshoe Dam (Township 7 North, Range 6 East, sections 3 and 4). Additional subpopulations have been located on and near Chalk Mountain (Township 8 North, Range 6 East, sections 15, 16, 21, and 22), Yavapai County. These subpopulations are found between 640 - 823 m (2,100 - 2,700 feet) elevation.

Other areas in the state have been searched for *P. subintegra*, but no other populations have been located (Albee 1986, Anderson 1986, Butterwick 1979, Warrick 1986, Boucher and Goodwin 1984). Most of these surveys have focused on areas in the Verde Valley and Tonto Basin. Additional surveys in potential habitat should occur to determine if undiscovered populations exist.

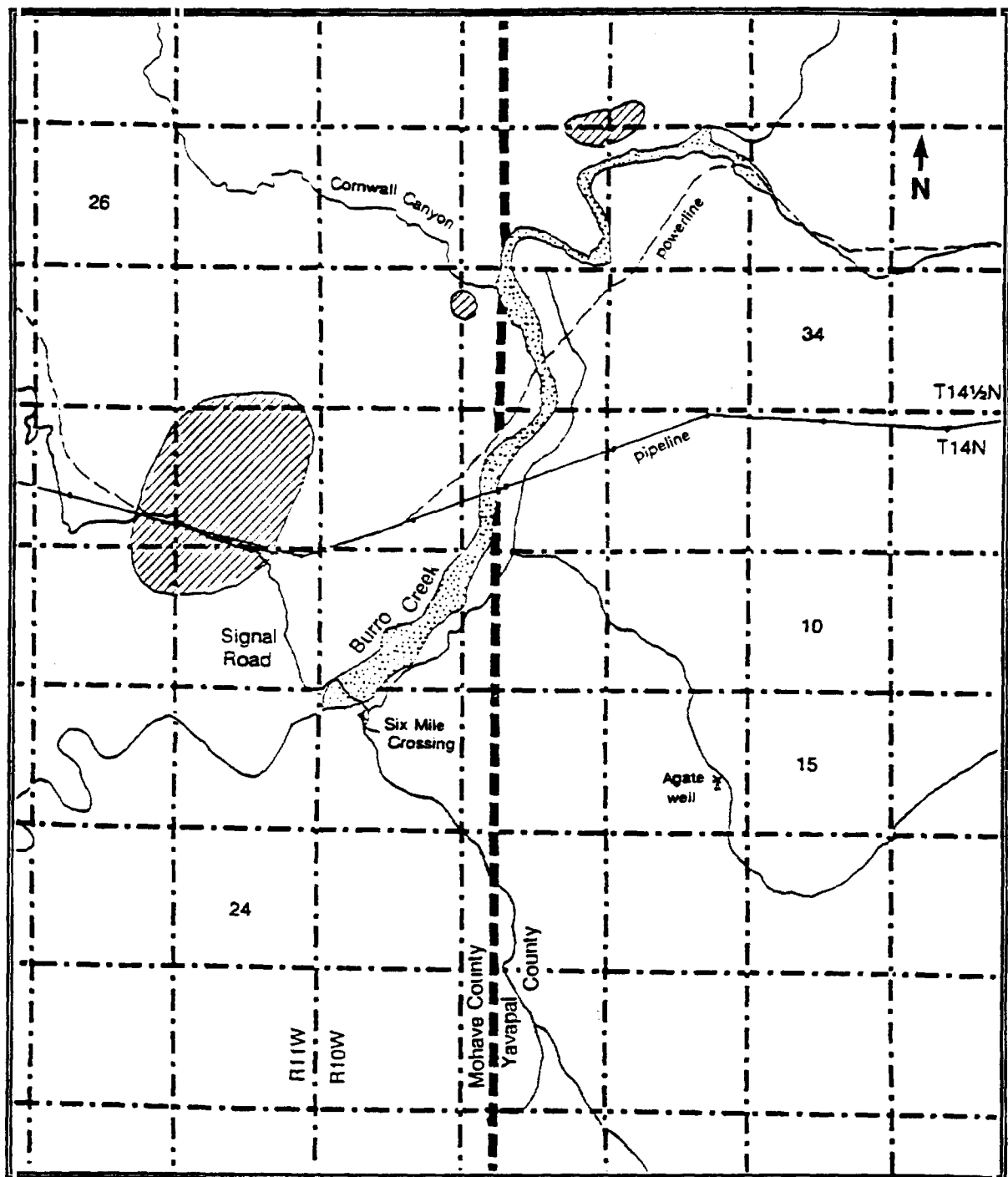


Figure 4. Diagonal lines indicate the areas occupied by *Purshia subintegra* at Burro Creek, Mohave and Yavapai Counties, Arizona.

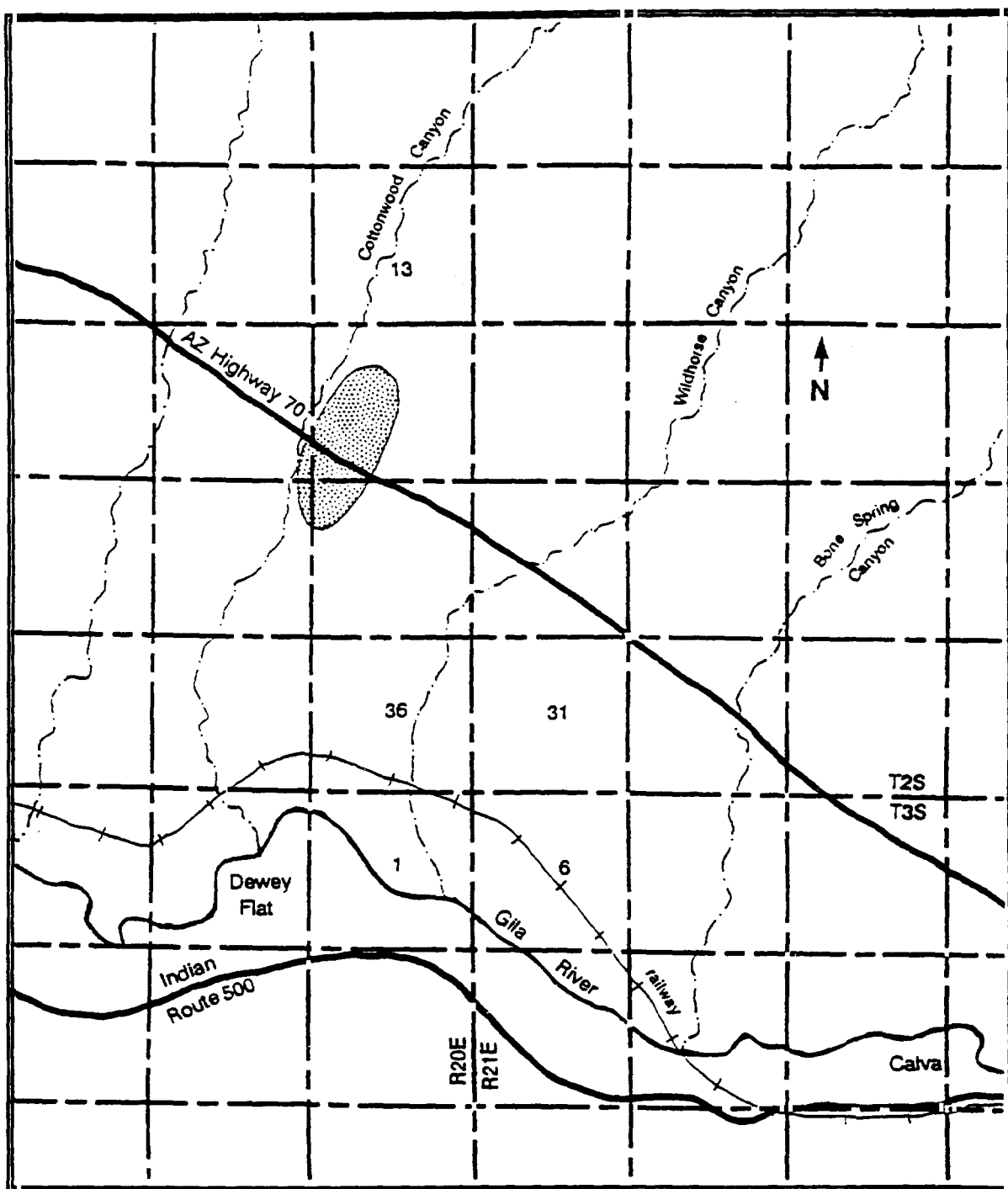


Figure 5. Shaded areas indicate the approximate boundaries of the *Purshia subintegra* population located near Bylas, Graham County, Arizona.

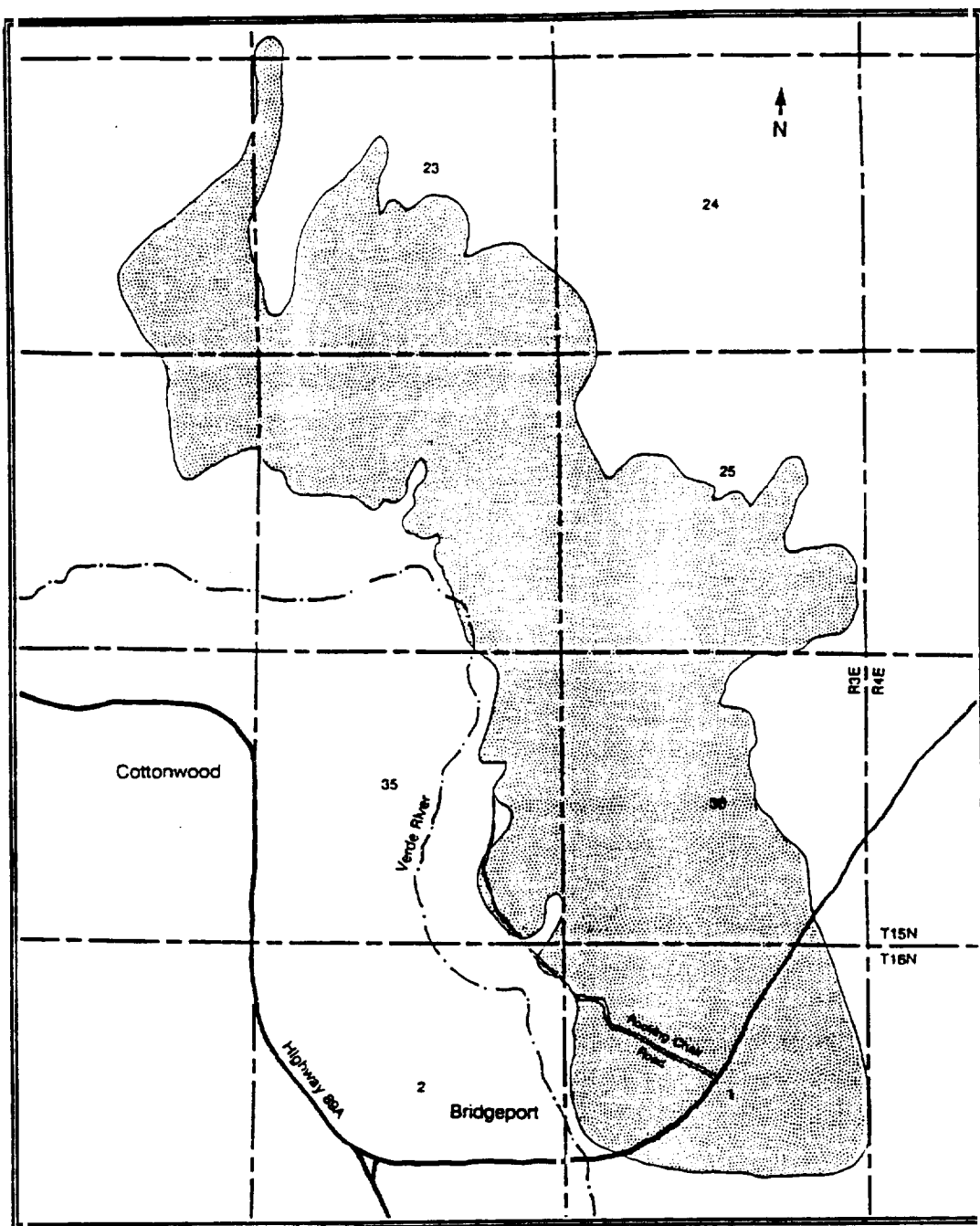


Figure 6. Shading indicates location of *Purshia subintegra* population in the Cottonwood area. Some *Purshia stansburiana* (typical and Verde Valley forms) may also occur in this area.

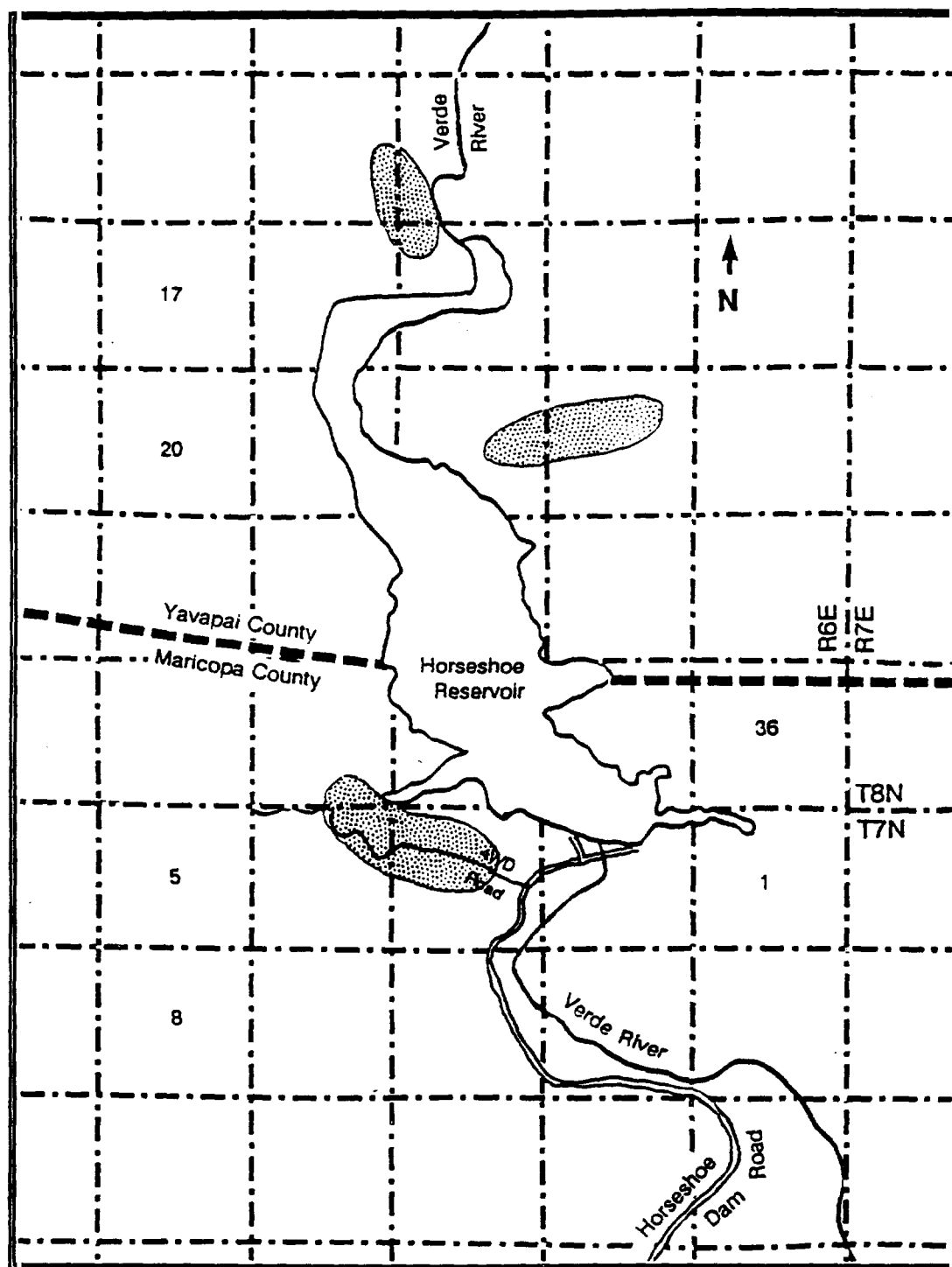


Figure 7. Shading indicates location of *Purshia subintegra* subpopulations near Horseshoe Lake, Maricopa and Yavapai Counties, Arizona.

Ecology

Associated Species

All four sites can be considered part of the *Larrea tridentata* - *Canotia holacantha* (Creosotebush - Crucifixion thorn) Association of the Arizona Upland Subdivision of the Sonoran Desertscrub (Brown 1982), because *Canotia holacantha* is a dominant at each site. The Burro Creek site contains some elements of the Mohave Desertscrub. Although *C. holacantha* is the most constant associate of *Purshia subintegra*, creosotebush is found only rarely. *Larrea* is a dominant on sites adjacent to the substrates supporting *P. subintegra*, but the density of *Larrea* drops abruptly and the species is nearly absent where the *P. subintegra* occurs. *Larrea* is apparently intolerant of the soils or is a poorer competitor than *Purshia subintegra* on those sites. The Arizona cliffrose population at Burro Creek occurs in an area that contains elements of Sonoran Desertscrub and Mohave Desertscrub.

Other dominant woody species at more than one site are: *Aloysia wrightii* (Wright lippia), *Baileya multiradiata* (desert marigold), *Berberis haematocarpa* (red barberry), *Caenothus greggii*, *Dalea formosa* (feather plume), *Dyssodia acerosa* (dogweed), *Eriogonum inflatum* (desert trumpet), *Glossopetalon spinescens*, *Fouquieria splendens* (ocotillo), *Gutierrezia sarothrae* (snakeweed), *Krameria parvifolia* (little-leaved rattany), *Oryzopsis hymenoides* (Indian ricegrass), *Parthenium incanum*, *Tiquilia canescens* (shrubby coldenia), *Melampodium leucanthum* (Plains blackfoot daisy), *Eriogonum fasciculatum* (flat-topped wild buckwheat), *Simmondsia chinensis* (jojoba), and *Ziziphus obtusifolia* (gray-thorn). Several authors have compiled more complete lists of *P. subintegra* associates in the Cottonwood area (Denham and Fobes 1992b, Jenkins 1991, Schaak and Morefield 1985, Boucher and Goodwin 1984, Butterwick 1979, Schaak and Morefield 1985, Anderson 1986, Reichenbacher 1986).

The disjunct ranges of several species parallel the disjunct pattern of Arizona cliffrose. Three Chihuahuan Desert species, *Polygala macradenia* (milkwort) and *Thamnosma texana*, and *Polygala scoparioides* reach the northwestern edge of their ranges with disjunctions on these deposits. Ten species of northern origins are disjunct into the Sonoran Desert from the Colorado Plateau: *Astragalus calycosus* var. *scaposus*, *A. newberryi* var. *aquarii*, *Eriogonum apachense*, *E. ericifolium* var. *ericifolium*, *E. ripleyi*, *Arenaria eastwoodiae*, *Polygala rusbyi*, and *Penstemon thompsoniae* (Thompson penstemon), *Physaria newberryi* (Newberry twinpod), and *Streptanthus cordatus* (Anderson 1986).

Four rare, Arizona endemic plants occur in the same habitat as Arizona cliffrose. The category 2 candidate Verde Valley sage (*Salvia dorrii* var. *mearnsii*) appears to be limited to the Verde Formation in the Verde Valley area. The category 2 candidate Ripley wild buckwheat (*Eriogonum ripleyi*) occurs in Arizona cliffrose habitat in the Verde Valley and near Horseshoe Lake. The Arizona cliffrose habitat near Bylas has not been surveyed for Ripley wild buckwheat; however, the category 2 candidate Apache wild buckwheat (*Eriogonum apachense*) is known to occur there. The Aquarius Plateau milk-vetch (*Astragalus newberryi* var. *Aquarii*) is endemic to the lacustrine deposits near Burro Creek.

Soils

All the sites consist of limy-tuff soils derived from Tertiary lacustrine (freshwater) lakebed deposits (Anderson 1986), on low, arid hillsides between 625 - 1,036 m (2,050 - 3,400 feet) elevation.

All soils are classified as sandy loams. Gravel content is significantly lower in soils occupied by Arizona cliffrose than in adjacent soils, reflecting their depositional environment in basins (Anderson 1986). Clay and silt content are

not significantly higher in the basins than in the adjacent soils, however. The mean value for pH is 8.3, with no significant difference between on-site and off-site soils (Anderson 1986, Anderson 1993). On-site soil samples are lower in phosphorus and organic matter and higher in magnesium than off-site samples (Anderson 1986, Anderson 1993). Soils supporting Arizona cliffrose populations at Burro Creek have high concentrations of magnesium and lithium (Bureau of Land Management 1993). These soils do not have the extremely low calcium-magnesium ratio of serpentine soils but fall within the normal range of 2:1 to 20:1 (Anderson 1986). The lower levels of phosphorus, nitrate, and organic matter are an indication of the infertility of these soils. On-site and off-site samples at a site in Dead Horse Ranch State Park were not significantly different in phosphorus and organic matter, suggesting that Arizona cliffrose is not necessarily limited to infertile soils (Anderson 1986, Anderson 1993). Anderson (1993) concludes Arizona cliffrose occurs on these infertile soils at Burro Creek and Bylas because there it can escape competition from creosote bush (*Larrea tridentata*) and other common Upper Sonoran Desertscrub plants, which are excluded from the sites by low soil fertility.

Each of the three lacustrine soils tested (Burro Creek, Dead Horse Ranch State Park, Bylas) by Anderson were deposited within basins quite removed from each other and consequently had different sources of eroded parent material and ash flows. Burro Creek soils had over twice the concentration of magnesium as the other sites, and Dead Horse Ranch State Park soils were higher in phosphorus and organic matter than the other two sites (Anderson 1986).

The Burro Creek area east of Highway 93 is extremely complex geologically, with various parent materials such as basalt, granite gneiss, granite, limestone, and tuff being exposed (Wilson and Moore 1959). Parent materials on *Purshia subintegra* Burro Creek sites consist of slightly metamorphosed volcanic ash

deposits and dolomitic limestone. Gypsum was not detected at this locality (Butterwick 1983). Arizona cliffrose is found on all aspects of the hills and terraces, and is found on slopes varying from 0 - 40 degrees.

At the upper end of the Verde Basin, the Verde Formation is a Pliocene limestone with interbedded clastic and tuffaceous sediments (Nations *et al.* 1981). Greatest densities of *Purshia subintegra* were found on open flat ridge-tops or other level areas near Cottonwood. Dense stands were also noted along shallow, first order drainages. It occurred on all but the steepest slopes. *P. subintegra* was found rooted in either white calcareous soils derived from a limestone member of the Verde Formation, red soils formed from a calcareous red sandy member of the Verde Formation, or a mixture of both (Schaak and Morefield 1985, Denham and Fobes 1992b). *P. subintegra* was not found on the Verde Formation at the southern end of the basin (Anderson 1986), which is stratigraphically lower and contains Miocene evaporite deposits (Nations *et al.* 1981).

At the Horseshoe Lake locality, an unnamed lacustrine deposit outcrops along the Verde River in a small unnamed basin between the Matzatza Mountains on the east and the New River Mountains to the west. The calcareous substrates are a mixture of materials, principally volcanic ashes with some limestone that had been weathered and transported from original sites and redeposited in river and lake bottoms. The calcium carbonate content of these materials is high and results in an alkaline soil. The poorly consolidated tuffs and sediments which characterize much of the Formation are highly unstable and erode rapidly, especially on the more steeply dipping outcrops (Reichenbacher 1986). Pollock (*in litt.* 1986) noted that the soils supporting Arizona cliffrose reacted with hydrochloric acid (indicating a high concentration of calcium carbonate), but adjacent soils did not.

At Bylas, *Purshia subintegra* grows on gypsum ridges on residual soil, not on decomposed substrate (Bingham 1977). Bureau of Land Management (BLM) soil scientists at Phoenix and Safford District offices believe that the soils developed on the Arizona cliffrose outcrops are most closely related to the Retriever Series. Retriever soils are shallow gravelly loams that develop over limestone bedrock.

Climate

Rainfall in the Sonoran desert occurs in the winter and summer. These rainfall periods are normally separated by spring and fall droughts. Annual precipitation at the four Arizona cliffrose sites and the Tonto Basin is nearly equitably distributed between winter and spring rainfall periods (Anderson 1993). Summers are hot and winters are mild. Average annual precipitation and average number of frost-free days for the four Arizona cliffrose populations are provided below (Sellers and Hill 1974).

Arizona cliffrose population	Inches of rainfall	Average number of frost-free days	Nearest weather station
Burro Creek	13.6 9.4	126	Bagdad Wickiup
Horseshoe Lake	14.5	no data	Horseshoe Dam
Bylas	8.8 11.7	249	Fort Thomas San Carlos Reservoir
Cottonwood	12.2	282	Cottonwood

Pollination Biology

The pollination biology of Arizona cliffrose was investigated by Fitts *et al.* (1993) at the Cottonwood population in 1991. They found that flowers may be pollinated on any of the first three days following anthesis (flower opening).

Arizona cliffrose flowers are pollinated primarily by bees in the superfamily Apoidea, including several native species. The introduced honeybee (*Apis mellifera*) was a common visitor to Arizona cliffrose flowers. By early May, honeybees were the most abundant pollinator, perhaps to the exclusion of native species. The second most abundant group of insects visiting Arizona cliffrose flowers were small, nondescript native bees in the genus *Dialictus*. Other pollinating insects included native bees in the families Anthophoridae, Colletidae, and Halictidae and one species of syrphid fly (family Syrphidae) (Fitts *et al.* 1993).

Arizona cliffrose is primarily cross-pollinated but is partially self-compatible (Fitts *et al.* 1993). Fitts *et al.* (1993) found that self-pollinated flowers produce significantly fewer seeds than flowers that are cross-pollinated. They also found that flowers blooming late in 1991 produced more fruits than flowers that bloomed early, but noted that this finding may be inconsistent between years.

Phenology

Arizona cliffrose begins blooming in late March and continues through early May. The flowering period of *Purshia subintegra* partially overlaps with the flowering period of *P. stansburiana*, which blooms adventitiously throughout the year. Phenology of life history events such as flowering and fruit dispersal may vary from year to year, depending on temperature, rainfall, and wind. Most Arizona cliffrose fruit develops during April in the Cottonwood area. Fruit dispersal occurs during the summer, when the summer rains dislodge seeds from plants. Timing of seed germination and seedling establishment is unknown.

According to Denham and Fobes (Denham *in litt.* 1993), most seedlings in the Cottonwood population emerge during early February to early spring. They have also seen newly emerged seedlings in the fall. However, they note that

their observations occurred during years of above-average precipitation and may not be typical.

Life History and Population Dynamics

Little is known about the life history traits of Arizona cliffrose. Age at first reproduction is unknown, as are the gross and net reproductive rates and the average or maximum longevity of plants. No demographic studies have been conducted in any of the populations to determine if recruitment is sufficient to maintain or increase the size of populations.

Mature Arizona cliffrose plants are capable of producing many seeds per year. Normally, hundreds of flowers are produced on each mature plant, which can reproduce for many years. Fitts *et al.* (1993) found that flowers in the Cottonwood area produced an average of 3 - 3.5 seeds per flower in 1991. The number of flowers and seed produced per plant may vary from year to year, depending on rainfall, temperature, plant vigor, amount of browsing, and other factors affecting reproductive output.

Two attempts to study germination requirements and rates have been made. Twenty seeds were collected on September 15, 1985, from the Cottonwood population, stratified (cooled) until December 30, 1985, and then germinated (Anonymous 1985). Final results were not recorded. For the second experiment, 14 seeds were planted on February 1, 1989, and placed in cold stratification at 12° Centigrade until April 24, 1989. One of those 14 seeds germinated (Maschinski *in litt.* 1993).

The influence of weather on seed production may explain why Butterwick (1979) observed no seeds in August and September 1976 and October 1978 at the Burro Creek population (Butterwick 1979). Frost or snow in the Burro Creek area is possible during late February and March when flower buds are developing

on Arizona cliffrose. Peck (BLM- Kingman Resource Area, pers. comm., 1993) noted that whole Arizona cliffrose branches were frozen and killed after spring temperatures dropped in 1991. Another explanation for the lack of observed seeds in 1976 and 1978 (Butterwick 1979) may be that the seeds had already dispersed.

Arizona cliffrose plants appear to be long-lived and capable of a large reproductive output. Plant species with this life history strategy tend to have high seed and seedling mortality and low recruitment rates. If Arizona cliffrose has this life history strategy, we would not expect to find large numbers of seedlings and juveniles in each population. However, we would expect a viable population to contain plants of differing ages or sizes. We do not yet know what recruitment rates are necessary to maintain population viability.

Recruitment rates appear to vary among populations. Denham and Fobes (pers. comm., 1992) have discovered areas within the Cottonwood population supporting a relatively large number of established seedlings. About 1980 there was a consolidation of grazing permits, which changed the pattern from continuous grazing to seasonal grazing. This resulted in reduced impacts to these areas, because the forage base increased and the grazing period was shortened.

In contrast to the Cottonwood population, the other three Arizona cliffrose populations do not appear to have sufficient recruitment. Although Peck and Cordery (BLM, pers. comm., 1993) have seen seedlings with cotyledons in the Burro Creek population, age/size class distribution appears heavily weighted towards older, large plants. As discussed below, livestock utilization of plants in this population has historically been high, perhaps explaining the lack of or low recruitment. More than ten years ago, several authors (Bingham 1977,

Butterwick 1979, Phillips *et al.* 1980) noted that reproduction at Burro Creek appeared to be insufficient to maintain the population.

Bingham (1977), Butterwick (1979), and Phillips *et al.* (1980) noted that reproduction at Bylas appeared to be insufficient to maintain the population. However, their observations conflict with those of Bureau of Indian Affairs (BIA), which found all age classes represented, including seedlings to senescent shrubs (F. Montague, BIA San Carlos Agency, *in litt.* 1986).

General Biology

The ability of Arizona cliffrose to recover after surface disturbance may depend on the severity of that disturbance. Where the soil profile is disturbed through digging, trenching, or other means, Arizona cliffrose may never recover or may take many decades to recover. As many as 25 years after disturbance, no colonization of severely disturbed areas along pipelines has occurred. However, in areas that received less disturbance, colonization appears possible. Reproducing plants and juveniles were noted by the authors along a seldom-used jeep trail leading to a water tank in the Cottonwood population. M. Baker (pers. comm., 1993) noted two young plants in a less disturbed area 30 - 40 feet away from a pipeline through the Burro Creek population and 3 or 4 seedlings nearby.

Propagation of Arizona cliffrose by stem cuttings has been tried but methods are not well developed. The Transition Zone Horticultural Institute (Milne 1986) took cuttings of Arizona cliffrose taken from Dead Horse Ranch State Park during the spring, summer, and fall of 1986 to determine rooting success. Cuttings taken in March had a 31% chance of rooting, while cuttings in July had a 56% chance of rooting. At the time the report was written, no results for cuttings taken in October were available. An earlier experiment was less successful at rooting cuttings of Arizona cliffrose (Anonymous 1985). The experiment

involved 16 cuttings taken in late June 1985. These cuttings produced roots but died three weeks after they were transplanted into pots.

The Transition Zone Horticultural Institute tried rooting Arizona cliffrose cuttings again in 1990 (Maschinski 1990). They collected 200 cuttings from 60 plants in the Burro Creek population, treated them with rooting hormone and placed them on mist benches on October 3, 1990. Within three months, 45 of these cuttings had rooted and were potted in standard potting mix. They re-treated 151 of the unrooted cuttings with rooting hormone. Fifty-seven of these rooted and were potted, but all had died by the end of April 1991 (Maschinski *in litt.* 1993).

The Transition Zone Horticultural Institute collected 144 cuttings from Dead Horse Ranch State Park in December 1991. Only four of these cuttings successfully rooted. Three of these plants are still living, have flowered and set seed, and are three feet tall (Maschinski *in litt.* 1993).

Land Management/Ownership

The Burro Creek Arizona cliffrose population occurs on Federal land managed by the BLM, Phoenix District, Kingman Resource Area. The Bylas population occurs on the San Carlos Apache Indian Reservation and Arizona Department of Transportation highway right-of-way. The U.S. Department of the Interior, including the BIA and Service, has Tribal Trust responsibilities, which include trust responsibilities for natural resources occurring on Indian Reservations. The Horseshoe Lake population occurs on Federal lands managed by the Tonto National Forest and Bureau of Reclamation (Reclamation). The Cottonwood population is on private lands, State Trust land managed by the Arizona State Land Department, Dead Horse Ranch State Park, and Federal land managed by the Coconino National Forest. Denham and Fobes (1992c) provide estimates of

the number of habitat acres managed by each State or Federal agency or private landowner in the Verde Valley. They estimated that 442 hectares (ha) (1,067 acres) of *P. subintegra* habitat exist in the Cottonwood area.

Management Issues and Concerns

Urbanization

Habitat loss due to urbanization is a serious threat for the Cottonwood Arizona cliffrose population. Urbanization does not appear to be a threat to the other three populations, which are either on Federal land, which precludes urbanization, or they occur where development is unlikely.

A significant amount of Arizona cliffrose habitat has already been lost due to development in the Cottonwood area, but the amount of habitat loss has not been estimated. The threat of urbanization continues, because some occupied habitat remains on private lands that could be developed and a substantial amount of habitat is on State Trust land.

The transfers of land from Federal ownership into private or State ownership is an indirect threat to Arizona cliffrose. These land exchanges significantly reduce the protections offered by the Endangered Species Act and may contribute to urbanization or other actions causing habitat loss or degradation. These types of transfers would be subject to section 7 consultation procedures.

If State land in the Cottonwood area is offered for sale and purchased by a private developer, the Arizona cliffrose population would be reduced and fragmented, significantly reducing the likelihood of survival and recovery of the recovery unit. In the past, the Coconino National Forest has proposed to exchange from Federal ownership into private ownership land parcels containing Arizona cliffrose habitat. In 1984, the Regional Forester instructed the Coconino National Forest Supervisor to withdraw sections of land containing Arizona

cliffrose from a proposed land exchange (Southwest Regional Forester, U.S. Forest Service, *in litt.* 1984). A similar land exchange was proposed in 1991, when the Coconino National Forest proposed the Bar-T-Bar land exchange. However, the Coconino National Forest has indicated that no lands containing endangered species will be exchanged out of Federal ownership (G. Goodwin, Coconino National Forest, pers. comm. 1993).

Mineral Exploration and Development

Mining and mining-related activities are a serious threat to the long-term survival of this species, particularly in the Burro Creek area. The soils supporting Arizona cliffrose populations are known to contain high quality bentonite (BLM 1993), a type of clay used for cosmetics and pharmaceuticals. Drilling and bulk sample procurement have reduced the number of plants and amount of available or undisturbed habitat in the Burro Creek area. In 1990, the BLM estimated that $30 (\pm 10)$ acres (12.4 ± 4.1 ha) of the total 140 acres (58 ha) of the core Burro Creek population has been disturbed and perhaps permanently lost due to mining activities (U.S. Fish and Wildlife Service 1990). In January 1991, assessment work occurred within the Burro Creek population that caused additional habitat loss, the loss of at least 13 Arizona cliffrose plants, and damage to several others (U.S. Fish and Wildlife Service 1990 and 1991, BLM 1990 and 1991).

To date, no mineral exploration or development has occurred within the Bylas (BIA *in litt.* 1986) or Cottonwood populations of Arizona cliffrose. The Coconino Forest Plan (U.S. Forest Service 1987) states that the Forest will withdraw the Verde Valley Botanical Area from locatable mineral entry within 10 years of the implementation of the Forest Plan. To date, no mineral withdrawal has occurred in the botanical area. However, the BLM has closed mining claims in Arizona cliffrose habitat near Cottonwood in the following sections: Township 16 North, Range 3 East, the SE1/4 of section 22, NW1/4 of section 23, northwest corner of section 25, and the northwest corner of section 26.

Mining activities have occurred near Chalk Mountain and Lime Creek in the vicinity of or within the Horseshoe Lake population (Southwestern Regional Forester, U.S. Forest Service, *in litt.*, 1994). Mineral exploration for copper, turquoise, uranium, zeolite, and sand and gravel occurred in these areas. In some cases claims were filed. The exploration was accompanied by varying levels of surface disturbance, mostly in the 1960s and 1970s.

Cattle and Feral Burro Browsing Effects

In 1987, the BLM- Kingman Resource Area began monitoring the effects of livestock browsing on Arizona cliffrose near Burro Creek with the objective of determining the amount of utilization. Internode distances on five branches were measured on each of 50 Arizona cliffrose plants. Cages were constructed around 25 Arizona cliffrose plants to prevent browsing by livestock, wild burros, and mule deer. Twenty-five plants were left uncaged to serve as a control. Their results showed that browsing activity resulted in 65% utilization of Arizona cliffrose (BLM 1993). This high level of utilization can reduce plant vigor and fecundity, cause lack of seedling establishment, and change the form class of Arizona cliffrose plants, causing them to look hedged. Under this level of utilization, more palatable, associated plant species may be overutilized, resulting in disturbed ecosystem functions and degraded ecological values.

The BLM continued monitoring Arizona cliffrose utilization after a fence was constructed in 1989 to exclude cattle and burros from an approximately one square mile area. This large enclosure included the caged and uncaged plants that had been monitored since 1987. After the fence was built, utilization of the Arizona cliffrose plants dropped to 16% in 1989 and 18% in 1990 (BLM 1993). Utilization of caged plants was similar to uncaged plants. These results indicate that livestock and burros were responsible for most of the browsing activity on Arizona cliffrose. Some browsing continues within the enclosure, probably from mule deer and other wildlife. Livestock and burros may occasionally enter the

exclosure if the fence is not maintained. Most plants appear to be responding favorably to the lower levels of browsing. However, it appears that some plants that were very heavily browsed over a long period of time may never recover.

Only observational data are available regarding the effects of livestock grazing on the Bylas Arizona cliffrose population. At the Graham County population, Bingham (1977) noted that no young plants were observed during a one hour search in the grazed open area, whereas juvenile plants were present along an adjacent fenced ungrazed highway right-of-way. In 1986, the BIA (*in litt.* 1986) noted that the absence of quantities of dried manure and lack of hoofprints to the north of Highway 70 indicated low grazing pressure. They also noted that Arizona cliffrose plants south of Highway 70 were browsed, probably because nearby Poison Spring offers a source of water for livestock and wildlife.

Grazing Management Systems

Cottonwood Population. Cattle grazing has occurred in the Cottonwood population of Arizona cliffrose for many decades. Until 1980 (D. Ward, Coconino National Forest, pers. comm., 1993), cattle had access to Arizona cliffrose habitat year-long. In 1989 the Coconino National Forest approved an interim Windmill Allotment Management Plan (AMP), which prescribed a deferred rest rotation system (Ward 1989). The Coconino National Forest (Coconino National Forest 1992, Ward 1992) revised the Windmill AMP in 1992 to better accommodate Arizona cliffrose management needs. The AMP addresses lands managed by the Arizona State Land Department and the Coconino National Forest, including the Verde Valley Botanical Area. Formal section 7 consultation on the revised Windmill AMP was completed on December 30, 1992, the date the Service issued a non-jeopardy Biological Opinion.

The Cottonwood population of Arizona cliffrose occurs in the Gyberg, Rocking Chair, and Cornville pastures covered by the Windmill AMP. Since 1992

when exclosure fences were built, no livestock grazing has occurred within the Rocking Chair and Cornville pastures. The AMP permits up to 750 head of cattle in the Gyberg unit for 20-30 days every other year during fall-winter spring periods under a deferred rest rotation system. After March 15 during these use periods, another 80 bulls may be added to the 750 head. A maximum of 20% utilization of key forage grasses is permitted in the Gyberg Unit inside the Verde Valley Botanical Area. A maximum of 50% is allowed in the Gyberg Unit outside the Verde Valley Botanical Area. Because plant cover is low and topography is rough within Arizona cliffrose habitat in the Gyberg Unit, livestock use is expected to be low. To verify this assumption, the Forest has committed to monitoring use of Arizona cliffrose while livestock are within the pasture (Ward 1992). In 1993, 500 head of cattle used the Gyberg pasture for 18 days (May 1 through May 18).

Burro Creek Population. The Burro Creek Arizona cliffrose population is within the Bagdad grazing allotment administered by the BLM- Kingman Resource Area. From at least 1938 to 1989, cattle used this allotment yearlong. There were no interior pasture fences. This type of grazing management can result in some areas receiving extremely heavy use, such as riparian zones or areas with particularly palatable plants, and light use in other areas, such as rocky uplands. A range inventory completed in 1978 determined the Bagdad Allotment to be in fair range condition with a static trend rating (Butterwick 1979, BLM 1992), an indication of overgrazing. The Arizona cliffrose site was given a condition class between fair and good and a trend rating of static (BLM *in litt.* 1987). Until 1989, livestock had uncontrolled access to Arizona cliffrose plants, resulting in the hedged growth form expressed by many of the plants.

Although the largest subpopulation of Arizona cliffrose at Burro Creek is now protected from livestock and burro grazing by an exclosure fence (see "Conservation Efforts"), livestock and burros are not excluded from the two

smaller outlying subpopulations. BLM issued a term grazing permit in 1992 (BLM 1992), but no formal section 7 consultation occurred when it was issued. The grazing management system that will be implemented in the area of these two subpopulations will be prescribed by the Bagdad Showcase AMP (BLM 1992). BLM has completed formal section 7 consultation with the Service on the proposed grazing system. The AMP will allow 280 yearlings to graze from October 1 through March 31 in the pasture containing Arizona cliffrose. The allotment contains two pastures. If BLM finds that utilization exceeds 20%, they will determine if reinitiation of formal consultation is necessary (Hall 1993). The BLM is predicting livestock grazing in the two subpopulations will be light because cattle will be less likely to travel in the area because of the rugged terrain and distance from water.

Horseshoe Lake Population. Cattle and sheep grazing began in the Horseshoe Lake area during the late 1870's. The two Arizona cliffrose subpopulations west of the Verde River were historically located within the Tangle Creek (sheep) Driveway (Tonto National Forest 1981). At one time, the sheep used the driveway only during drives that occurred at most once per year (D. Pollock *in litt.* 1986). No sheep drives have occurred for many years (Tonto National Forest 1981, Tonto National Forest Supervisor *in litt.* 1987 and 1992). The Tonto National Forest (1981) classified 50% of the sheep driveway as unsuitable for grazing, and the remaining area of suitable range was judged to be in poor range condition. Five years later, Pollock (*in litt.* 1986) visited the Arizona cliffrose subpopulation near Horseshoe Dam and noted that the range condition was poor to very poor. Arizona cliffrose plants appeared to have low vigor and were heavily browsed by wildlife (Pollock *in litt.* 1986).

The Arizona cliffrose population near Horseshoe Lake, with the exception of a part of the subpopulation near the dam, is contained within the Sears Club-Chalk Mountain grazing allotment, which encompasses 72,591 acres (30,053

ha). In 1984, the Tonto National Forest issued a term grazing permit that allows 746 adult cattle year-long and 398 winter yearlings in the allotment. Livestock grazing is guided by the Sears Club-Chalk Mountain AMP (Fenner 1985, Tonto National Forest 1985). At the time the AMP was completed, Arizona cliffrose was not yet known in the allotment.

The Sears Club-Chalk Mountain AMP (Fenner 1985) prescribed a 5-pasture rest-rotation system. The Arizona cliffrose subpopulation to the west of the Verde River and north of the dam is in the Lower Chalk Pasture, which is grazed every other year from December 15 to April 30. Allowed percent utilization in this pasture is 40%, which equates to 55% use on key species such as side-oats grama (*Bouteloua curtipendula*).

The Arizona cliffrose subpopulation near Horseshoe Dam is divided by a livestock fence that divides two allotments. Arizona cliffrose plants to the south of that fence are within the St. Clair Allotment. No livestock grazing has occurred on this allotment since 1992, when grazing permits were cancelled (Tonto National Forest Supervisor *in litt.* 1992).

Bylas Population. Nothing is known about livestock grazing management within Arizona cliffrose habitat on the San Carlos Indian Reservation.

Roads and Utilities

All of the Arizona cliffrose populations have roads and/or utility right-of-ways within or near them. The Burro Creek population is divided by a graded dirt road paralleled by the Southern Union Gas Company pipeline and Arizona Electric Power Cooperative Incorporated high voltage power line. The gas pipeline has been in existence since at least 1969 (Butterwick 1979). No estimate of the amount of habitat lost to these developments in the Burro Creek area has been made. The Kingman Resource Management Plan (Kingman RMP) (BLM 1993)

proposed a one-mile wide utilities corridor that overlies Arizona cliffrose habitat. The BLM may grant right-of-ways through this utility corridor (BLM 1993).

A graded dirt road (Forest Road 205) and a gated road (Forest Road 530) passes near one of the three Horseshoe Lake subpopulations. Forest Road 479 passes near a second subpopulation. U.S. Highway 70, a two-lane paved road, bisects the population near Bylas.

Numerous paved and dirt roads pass through the Cottonwood population. Highway 89A nearly forms the eastern border and Rocking Chair Road passes through the Arizona cliffrose habitat. Its expansion is being planned. Other roads to access housing or for recreational purposes create a network through the habitat.

Roads and trails have direct and indirect effects. Road surfaces constitute lost habitat. The amount of habitat and number of plants lost to roads have not been estimated. Roads can change the local hydrology, affecting the amount of precipitation received and absorbed in a local area, changing the direction and speed of runoff, and perhaps changing erosion rates and patterns. These changes can adversely or beneficially affect survivorship and fecundity of individuals. Soil compaction occurs in areas of moderate to heavy vehicle use.

Roads can provide access to ORV and other users that may adversely affect Arizona cliffrose and its habitat. ORVs can destroy young plants, harm mature plants, prevent seedling establishment or seed germination, cause soil compaction, and otherwise disrupt the soil surface.

Arizona cliffrose plants have colonized a lightly used vehicle trail on the Coconino National Forest. These plants indicate that Arizona cliffrose in the

actively reproducing Verde Valley population can recover after light soil surface disturbance.

Unknowningly, local residents of the Verde Valley have been using Arizona cliffrose habitat as a parking lot. The parking area is located at the intersection of Rocking Chair Road and U.S. Highway 89A. The area of impact has been expanding during recent years, increasing the number of plants and amount of habitat already lost.

The Coconino Forest Plan (U.S. Forest Service 1987) states that the Forest will manage roads adjacent to the Verde Valley Botanical Area to prevent "vehicular intrusion." In the same document, the Forest committed to blocking and obliterating existing roads entering the area within the first ten years of plan implementation. To date, road blocking and obliteration has not yet occurred.

Recreation

The Cottonwood population is adversely affected by recreation of several types. An unofficial shooting range near the eastern portion of this population on the Coconino National Forest has caused the loss of an unknown number of plants and acres of habitat. Shooters park within an Arizona cliffrose population at the base of a small hill and shoot into the population on the hill. The soil at the well-used parking area and roads leading to the shooting range is compacted and eroding, devoid of vegetation, and probably incapable of supporting cliffrose plants unless restored. The area is used not only by shooters, but also by night-time recreationists.

In addition to the shooting range, other spots in the Arizona cliffrose Cottonwood population are frequented by night-time recreationists. These "party spots" are generally severely impacted by vehicles, devoid of vegetation, and littered with trash.

ORV recreationists drive through the Cottonwood population, in some cases ignoring signs or cutting fences to gain access to prohibited areas. A fence completely surrounds a section of Arizona State Trust land, which was used by ORV users despite trespass notices.

The primary damage to Arizona cliffrose habitat in the Cottonwood area has occurred in Township 16 North, Range 3 East, section 36 by vehicles entering the section from the west. The State Land Department has been successful at notifying the offenders and eliminating this use (Denham *in litt.* 1994). Denham and Fobes (1992d) also noted ORV damage in the southeast corner of Township 16 North, Range 3 East, section 22 and the northeast corner of section 27. The ORV users entered a parcel of private land via the Coconino National Forest and rode across the property.

ORVs are not currently a problem at Horseshoe Lake. The Tonto National Forest Plan (U.S. Forest Service 1985) closed the area to ORV use except where posted as open but has minimally enforced the closure. Despite the presence of a nearby lake and campground, ORV use has not yet been reported within the subpopulations.

The amount of recreational activity occurring within the core Burro Creek subpopulation is poorly known. Increased recreational activity may occur within the Clay Hills Area of Critical Environmental Concern (ACEC) when the Burro Creek campground is developed (BLM 1993). The Burro Creek site is a well-known destination for rock collecting enthusiasts. These visitors may affect Arizona cliffrose by turning over rocks and disturbing seedling establishment microsites. They also may occasionally drive short distances across country to reach collecting sites and crush plants. Whether or not these visitors adversely affect Arizona cliffrose is unknown.

Limitation of Pollinators

Based on the results from their pollination biology studies in the Verde Valley, Fitts *et al.* (1993) suggest but do not conclusively demonstrate that a limitation in pollinators may be limiting reproduction. They base their hypothesis on the following results: 1) open-pollinated control flowers produced fewer fruits and seeds than flowers from the xenogamy treatment (pollen from one flower transferred to a flower on a different plant); and 2) flowers produce fewer fruits during the early part of the blooming season, when competition for pollinators is greatest, than they do during the latter part of the season.

Control of Insect Pests

General pesticides are often used to control cropland insect pests and sometimes used to control rangeland insect pests. Two Arizona cliffrose populations (Horseshoe Lake and Cottonwood) occur very close to lands under cultivation. A private parcel of land near Horseshoe Dam is being cultivated to provide food for livestock. We do not know if pesticides are currently being applied on the cultivated lands near Arizona cliffrose populations.

Four Arizona cliffrose populations occur in areas that are grazed. High densities of rangeland pests have never been reported within Arizona cliffrose populations. If problem densities develop, however, they may be accompanied by proposals from Federal and State agencies to apply chemical controls, including general pesticides.

General pesticides such as malathion, a commonly used rangeland and cropland pesticide, can drastically decrease target and non-target insect populations. Insect population sizes are regulated by a number of variables, including weather, inter- and intra-specific competition, vertebrate predators, and insect predators and parasitoids (Belovsky 1989, Wang and Walgenbach 1989, Hostetter *et al.* 1989, Dysart and Onsager 1989, Lockwood 1993). General

pesticides will kill target herbivorous insects as well as the insect predators and parasitoids that regulate the herbivores. Herbivorous insects and their predators and parasitoids are usually in a dynamic balance, rarely reaching high, damaging densities except in unnatural circumstances such as the introduction of non-native pests or in association with various agricultural practices including livestock grazing (Auerbach 1991, Brusven and Fielding 1989, Belovsky 1989). For a review of the field experiments and models of arthropod predator-prey systems that demonstrate this dynamic ecosystem balance, see Hassell (1978).

Herbivorous insects recover more quickly after pesticide applications than do their predators and parasitoids because herbivores tend to have a higher fecundity and shorter generation time. Consequently, herbivorous species will more quickly become resistant to chemicals, and their populations will rebound faster and typically at higher densities because predator/parasitoid controls are lost or reduced. Thus, general pesticide applications tend to exacerbate insect population imbalances rather than resolve them.

Concern about applying chemical pesticides within or near endangered plant populations has tended to focus on the adverse effects of pesticides on pollinators. For plants that depend on insects for pollination, seed set may be drastically reduced when pollinator populations are reduced by pesticides (Tepedino and Griswold 1989). Avoiding the blooming period of endangered plants may not remove these adverse effects. Fitts *et al.* (1993) provide the following explanation:

It is obvious that, for the plant, the most dangerous time to spray is during the blooming period. It is less obvious that it may also be risky to spray when bloom is past; many important pollinators are either eusocial, or multivoltine species, i.e., adults are present throughout the growing season, foraging on other

plants. These adults are the progenitors of the next years' pollinator crop; removing them will eliminate progeny and, thus the number of pollinators flying in the following year.

Information needed to effectively manage insects as part of the ecosystem containing Arizona cliffrose includes the identification of all insects beneficial to Arizona cliffrose, including pollinators, and an understanding of their life histories and habitat needs. Until such information is obtained, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service has agreed to restrict certain pesticides within a 4.8 km (three-mile) radius of Arizona cliffrose populations.

Herbicides

Herbicides are sometimes used to control plant growth along paved roads. Although paved roads pass through the Verde Valley and Bylas Arizona cliffrose populations, we do not know if herbicides are used there. Herbicides should not be used along roadsides within Arizona cliffrose populations because treated plants are destroyed.

Inundation

Arizona cliffrose plants and habitat were probably inundated when Horseshoe Dam and its spillway were built on the Verde River in 1944-1946 (FraserDesign 1991). Additional plants and habitat were probably lost when the conservation pool level of Horseshoe Lake was raised in the 1950's to the current elevation of 618 m (2,026 feet). Habitat inundation most likely occurred in the Chalk Mountain area. If the height of the conservation elevation is increased further, the action would probably inundate additional plants and habitat. The Salt River Project, a utility company, operates the reservoir on a daily basis without specific approvals from Reclamation (Project Manager, Arizona Projects Office, Bureau of Reclamation, *in litt.* 1994).

Federal Land Management Plans

The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701 *et seq.*) and National Forest Management Act of 1976 (NFMA) (16 U.S.C. 1600 *et seq.*) directs Federal agencies to prepare programmatic-level management plans that will guide long-term resource management decisions. Programmatic-level management guidelines for three Arizona cliffrose populations are provided in three management plans prepared under the authority of FLPMA and NFMA. The Coconino National Forest Management Plan was signed in 1987 and covers the Arizona cliffrose population in Cottonwood. The Tonto National Forest Plan was signed in 1985 and covers the Horseshoe Lake Arizona cliffrose population. The Kingman Resource Area Proposed Resource Management Plan and Final Environmental Impact Statement was issued in 1993 (BLM 1993). It will guide management for the Burro Creek population.

Kingman Resource Area Management Plan

The Kingman RMP (BLM 1993) states that the objective of special status species management is to provide for the recovery of listed species, to manage other species to avoid the need to federally list them, and to improve habitat of special status species.

The Kingman RMP designated the 451 ha (1,114 acre) Clay Hills ACEC. This ACEC contains the largest subpopulation of Arizona cliffrose in the Burro Creek area but not the two smaller, more recently discovered subpopulations. The stated goal is to maintain a viable population of Arizona cliffrose. The following items appear in the Management Prescription for Clay Hills ACEC Crucial habitat for Arizona cliffrose:

- Propose designation of 1,114 acres of public lands as an area of critical environmental concern.
- Limit off-highway vehicle use to designated roads and trails.

- Withdraw 1,114 acres from mineral entry, subject to valid existing rights, and mineral leasing and do not allow mineral material disposals;
- Seek to acquire existing mining claims through voluntary relinquishment.
- Require mining plans of operation and a mandatory bonding for all mineral exploration and development activities, including casual use.
- Eliminate unnecessary roads and trail.
- Post the area with Native Plant Law protection signs.
- Do not allow removal of native plants.
- Assess the status of *Purshia* by continuing to monitor plants within permanent study plots.
- Continue to exclude grazing by livestock and burros.
- Monitor the effects of browsing by deer and modify fence to exclude deer if necessary.
- Prohibit camping.
- Evaluate all other land use authorizations for compatibility with goals and objectives of the ACEC.
- Incorporate specific provisions identified in the draft recovery plan for Arizona cliffrose into the ACEC plan.

These actions and monitoring will occur, given budgetary constraints and availability of personnel.

If the BLM finds, through monitoring efforts, a five year downward trend in Arizona cliffrose population numbers, age/class disparity, shrinking distribution or range contraction, the plan states that BLM will review appropriate decisions or activity plans (BLM 1993).

Management within the proposed ACEC would differ from that of the area outside the proposed ACEC containing the other two Arizona cliffrose subpopulations. In these areas, ORV use is limited to existing roads, trails, and

washes. The BLM should provide for primitive motorized recreation. No Mining Plans of Operation are required for work under 0.02 hectare (5 acres) and free-use permits for mineral materials should be issued as appropriate (BLM 1993).

Tonto National Forest Plan

The Tonto Forest Plan (U.S. Forest Service 1985) does not specifically mention Arizona cliffrose because the population at Horseshoe Lake was not discovered until 1985, the same year the plan was finalized. However, the Forest Plan sets forth some general guidelines for listed species. One of the goals of the plan is to increase population levels of threatened and endangered species. The mission of the management direction is to promote quality wildlife and fish habitat, including preserving habitat for known threatened and endangered species.

The Tonto Forest Plan has a number of Forest-wide management prescriptions, some of which apply to Arizona cliffrose. One prescription is to identify, survey, map, and analyze habitat for all Federally listed species; identify management conflicts and enhancement opportunities; and correct any management conflicts or problems. Another Forest-wide prescription is to continue to clear all projects for listed, proposed, and candidate plant and animal species.

The Tonto Forest Plan has specific management prescriptions for Management Areas. Most of the Arizona cliffrose in the Horseshoe Lake area occurs in Management Areas 1E, and some occurs in 1F. The immediate area around Horseshoe Lake (Management Area 1E) was withdrawn in 1987 for reclamation purposes by Reclamation. Within the withdrawn area, a Master Interagency Agreement between the Forest Service and Reclamation gave Reclamation the responsibility of operating and maintaining Horseshoe Lake, Horseshoe Dam, and project-related facilities (U.S. Department of the Interior and

U.S. Department of Agriculture 1987). Reclamation maintains responsibility for the protection and safety of Reclamation works and facilities. The Forest Service has surface management responsibilities, including management of Arizona cliffrose, within the withdrawn area. If Reclamation were to propose a project that may affect Arizona cliffrose, both Reclamation and the Tonto National Forest would have Endangered Species Act section 7 consultation responsibilities. Through a supplemental agreement made in 1991, Reclamation will relinquish all withdrawals not needed for Safety of Dams work by 1998 (U.S. Department of Interior and U.S. Department of Agriculture 1991).

Coconino National Forest Plan

The Coconino Forest Plan (U.S. Forest Service 1987) designated the 472 ha (1,140 acre) Verde Valley Botanical Area for the protection of the unique plant community, which includes Arizona cliffrose. This Forest Plan states that the management emphasis of the botanical area is to:

. . . maintain, as nearly as possible, existing conditions and natural processes for public enjoyment, demonstration, and study. Interpretive and educational demonstration opportunities are emphasized and enhanced through selective facility development. Natural events are not rehabilitated. Off-road driving is prohibited.

The Coconino Forest Plan (U.S. Forest Service 1987) calls for the range resources within the Verde Valley Botanical Area (Botanical Area) to be managed, through approved allotment management plans, to protect the uniqueness and/or ecological condition. The Botanical Area does not contain all of the *Purshia subintegra* plants and habitat on the Coconino National Forest.

Legal Protections

The Endangered Species Act (16 U.S.C. 1531 *et seq.*) extends a number of protections to endangered plants. Endangered plants can not be imported into or exported from the United States without a permit. Interstate or foreign commerce is prohibited, as is the removal and reduction to possession or malicious damage or destruction of listed plants on lands under Federal jurisdiction. It is also unlawful to remove, cut, dig up, or damage or destroy any listed plants in knowing violation of any law or regulation of any state or in the course of any violation of a state criminal trespass law. Section 7 requires all Federal agencies to use their authorities to conserve listed species. It also requires all Federal agencies to consult with the Service when an action they permit, fund, or carry out may affect listed species.

The Arizona Native Plant Law (A.R.S. Chapter 7, Article 1) protects Arizona cliffrose as a highly safeguarded species. The provisions of the Arizona Native Plant Law significantly strengthen the protections offered by section 9 of the Endangered Species Act because a violation of the Arizona Native Plant Law is also a violation of the Endangered Species Act. To legally collect this species on public or private lands in Arizona, a collector must obtain a permit from the Arizona Department of Agriculture (ADA). Permits may be issued for scientific and educational purposes only. Without a permit, it is unlawful to destroy, dig up, mutilate, collect, cut, harvest, or take any living highly safeguarded native plant from private, State, or Federal land. However, private landowners and Federal and State public agencies may clear land and destroy habitat, after giving the ADA sufficient notice to allow plant salvage to occur. Despite the protections of the Arizona Native Plant Law, legal and illegal damage and destruction of plants and habitat occurs.

The Lacey Act (16 U.S.C 3371 *et seq.*), as amended in 1982, also provides some protection for Arizona cliffrose. Under this Act it is prohibited to import, export, sell, receive, acquire, purchase, or engage in the interstate or foreign

commerce of any plant taken, possessed, or sold in violation of any law, treaty, or regulation of the United States, any Indian Tribal law, or any law or regulation of any State.

The NFMA directs the U.S. Forest Service to manage ecosystems to sustain the production of goods and services on National Forests. The NFMA and its implementing regulations require the U.S. Forest Service to manage for multiple uses while providing a sustained yield of products and services without impairing ecosystem productivity. It calls for the protection, preservation, and, where appropriate, improvement of the quality of renewable natural resources.

Research and Conservation Efforts

The BLM has surveyed potential habitat in the Burro Creek area, has done fecal analyses, and has established monitoring plots to determine grazing effects on the Burro Creek population (see discussion above). In 1989, the BLM constructed a fence that excludes cattle and burros from the most of the largest subpopulation. The other two Arizona cliffrose subpopulations in the Burro Creek area are not within the enclosure fence because they were discovered after the fence was built.

In 1983 and 1984, the BLM analyzed feces found within the Arizona cliffrose Burro Creek population to determine the source of browsing observed there (Peck, *in litt.* 1993). Arizona cliffrose was not found in livestock feces but was present in mule and wild burro feces, a result that conflicts with observations and utilization data. Observers have noted wildlife, livestock, and deer browsing on Arizona cliffrose plants. The branches exhibited a browsing style typical of burros and livestock (Peck, *in litt.* 1993). Utilization of Arizona cliffrose plants dropped from 65% to 15 - 18% after livestock and burros were excluded from

this subpopulation. These latter results provide further support to the conclusion that livestock and burros were the source of the majority of utilization.

In 1987, the Coconino National Forest established 18 100-foot (30.5 meter) transects to monitor population trends in the Verde Valley Arizona cliffrose population. Plant frequency was measured in the transects. The transects were relocated in April 1993 and re-run in October 1993.

In 1992, the ADA supplied signs that were put on the fence to notify the public about the protections offered by the Arizona Native Plant Law. These signs were illegally taken shortly after they were posted (B. Denham and N. Fobes, pers. comm., 1994).

Volunteers B. Denham and N. Fobes have explored the Verde Valley area, accurately mapped occurrences of *Purshia subintegra*, and are continuing to study its morphology and pursue its conservation.

PART II - RECOVERY

Recovery Objective

The Endangered Species Act charges all Federal agencies with the responsibility of contributing towards the recovery of listed species. Recovery plans set forth a program of actions that the Service believes are needed to achieve recovery. The main objective of this recovery plan is to outline the management actions and research needed to reclassify Arizona cliffrose from endangered to threatened and to manage its habitat so that the four currently known populations can be sustained in their natural habitat in Arizona.

Recovery Units

In guiding Federal agencies to preserve endangered and threatened species and the ecosystems upon which they depend, the Endangered Species Act sets a goal of preserving biological diversity. The survival and recovery of listed species depends upon management and protection of diversity at the genetic, population, species, community, and ecosystem levels. The survival and recovery of Arizona cliffrose will depend upon the successful management and protection of all four known populations and the ecosystems upon which they depend. Survival and recovery of each of these populations is needed to ensure the preservation of the species' genetic diversity, the evolutionary history of each population and the species, and the unique communities and ecosystems of which Arizona cliffrose is a part. To achieve this goal, this recovery plan identifies Arizona cliffrose "recovery units" that are analogous to the Cottonwood, Burro Creek, Bylas, and Horseshoe Lake populations. These populations or recovery units are indicated as the shaded areas in Figures 4 - 7 (pages 16-19).

Each recovery unit is needed to maintain the genetic diversity of the species. The four *Purshia subintegra* populations are now genetically isolated from one another and have genetically differentiated over time. Reichenbacher (pers. comm. 1993) states that morphometric measurements of a *Purshia subintegra* individual and discriminant function analysis can be used to determine the population from which a plant originated with about 70% accuracy. This degree of accuracy indicates that populations have differentiated over time. By combining morphometric and preliminary DNA analysis, Mount and Logan (1993) were able to distinguish four unique *P. subintegra* populations. These results imply that each population or recovery unit of Arizona cliffrose is genetically unique and therefore necessary to maintain the genetic diversity of the species.

Each population also represents a unique element in the evolutionary history of *Purshia subintegra*. The currently accepted hypothesis is that gene exchange between *P. subintegra* and *P. stansburiana* may have occurred in some areas thousands of years ago. Some populations or population segments may not have experienced any gene exchange, while other populations or segments may have experienced significant gene exchange with *P. stansburiana*. This evolutionary history contains valuable information about the dynamic process of evolution during global climate change.

Each of the four plant assemblages containing Arizona cliffrose is different from the others. At Burro Creek, Arizona cliffrose occurs with juniper trees and Mohave desert elements, unlike any other population of Arizona cliffrose. Only in the Cottonwood area is Arizona cliffrose found with Verde Valley sage and Ripley wild buckwheat. The only place where Arizona cliffrose and Apache wild buckwheat are sympatric is near Bylas. The plant assemblage containing Arizona cliffrose at Horseshoe Lake is unlike the latter three. Here, Arizona cliffrose occurs with Ripley wild buckwheat but not Verde Valley sage. To preserve the

diversity of assemblages containing Arizona cliffrose, the survival and recovery all four recovery units must be assured.

Protection of all four Arizona cliffrose recovery units will contribute to the maintenance of diversity on a landscape or ecosystem level. Plant communities containing Arizona cliffrose are different from surrounding communities because creosote bush is rare or lacking in the former community type. The limestone deposits create a noticeable patch or discontinuity in habitat that contributes to landscape and ecosystem diversity.

Recovery Criteria

Arizona cliffrose is a long-lived species that has already undergone significant habitat loss and degradation. Recovering the species and demonstrating population viability and stability will necessarily take a long time. To reclassify (downlist) Arizona cliffrose from endangered to threatened, the following criteria must be met:

Downlisting Criterion 1: Scientific data indicate each of the recovery units sustain a population that is viable or that is on a significant upward trend towards viability that is maintained for at least 15 years.

Downlisting Criterion 2: Unfragmented and high-quality habitat sufficient to ensure long-term survival and recovery is protected within each recovery unit. The following specific commitments should be made to prevent further habitat loss and/or degradation:

1. Livestock grazing within the four recovery units meets standards set in recovery task 3b.
2. Recovery task 3a is met for all four recovery units.
3. Written commitments to retain all Federal lands containing Arizona cliffrose are made.
4. Lands containing Arizona cliffrose that are currently private or managed by Arizona State agencies should be protected from further habitat loss or degradation.
5. Off-road vehicle traffic is prohibited within the four recovery units and designations effectively remove traffic within occupied or recoverable Arizona cliffrose habitat.

Downlisting Criterion 3: Regulatory mechanisms or written land management commitments that provide for adequate long-term protection of Arizona cliffrose and its habitat are being implemented and will continue to be implemented after downlisting. These protections must be sufficient to ensure the long-term recovery and survival of each recovery unit. Recovery task 1 must be met to achieve downlisting criterion 3.

Downlisting Criterion 4: The Service determines that Arizona cliffrose is no longer an endangered species, as defined by the Endangered Species Act. After downlisting criteria 1 - 3 are met, the Service should review the status of the species to determine if downlisting is appropriate. This decision will depend, in large part, on the outcome of information collected by conducting the research and studies recommended in recovery task 2.

As new scientific and commercial information becomes available, the Service will review these recovery criteria to determine if they remain appropriate.

Due to the present number and significance of threats and the unknown nature of its life history and habitat requirements, it is not possible at this time to predict what measures will be sufficient to support delisting. Tasks necessary to accomplish reclassification should provide the information necessary to determine if delisting will be possible and what the delisting objectives and criteria should be. After downlisting is accomplished, this plan will be revised to establish specific delisting objectives.

Outline of Recovery Actions

Accomplishment of the recovery actions described in this outline is needed to reduce or eliminate human-caused effects in each recovery unit and to achieve the downlisting criteria. Recovery actions are listed in a step-down form in which broad categories of recovery actions are stepped down to specific tasks. Tasks listed here also appear in the Implementation Schedule (Part III of this plan), in which costs and scheduling are estimated and lead Federal agencies are identified for specific actions.

1. Produce and implement management plans for each of the four recovery units. This recovery task must be completed before recovery criterion 3 can be met. Commitment of the appropriate Federal and State land management agencies and the San Carlos Indian Community towards managing this sensitive habitat is critical to the recovery and survival of Arizona cliffrose. If new populations are found, management plans covering those populations should be produced and implemented.

- 1a. Develop and implement a conservation strategy to recover Arizona cliffrose and its ecosystem on the San Carlos Apache Reservation (SCIR). The recovery of Arizona cliffrose depends on the preservation and maintenance of the population near Bylas, which is under the management of the San Carlos Tribe. The Tribe should produce a conservation strategy for Arizona cliffrose on the Reservation. This document should represent the commitment of the Tribe to ensure the maintenance of Arizona cliffrose populations and habitat on the SCIR. The conservation strategy should identify the threats to the species on the Reservation and make management recommendations that will eliminate or significantly reduce those threats.
- 1b. Designate or expand Special Management Area designations for populations occurring on Federal lands managed by the U.S. Forest Service and BLM. The Coconino National Forest has designated the Verde Valley Botanical Area (VVBA), which provides management direction and some habitat protection to most of the Arizona cliffrose population at Cottonwood. However, the VVBA should be expanded to include all parts of the recovery unit occurring on National Forest lands. If Arizona cliffrose populations are located on the Prescott National Forest or other Federal lands, designation of a Special Management Area should be considered.

The Tonto National Forest should designate a Botanical Area or other equivalent special management area to protect the Horseshoe Lake recovery unit.

The BLM should protect the Burro Creek recovery unit by designating the area as an Area of Critical Environmental Concern, including all subpopulations.

- 1c. Develop and implement written conservation strategies for populations occurring on Federal lands. The BLM, Tonto National Forest, and Coconino National Forest should produce conservation assessment/strategies that will guide the management and protection of Arizona cliffrose on Federal lands they manage. These documents should set forth the strategies to be used to eliminate or minimize threats to Arizona cliffrose and meet the recovery criteria. If new populations are found on Federal lands, conservation strategies should be developed or expanded.
- 1d. Develop conservation agreements or easements between the Service and State or private landowners for populations occurring on State or private lands. Currently, a significant portion of the Arizona cliffrose population at Cottonwood occurs on State lands. An agreement between the State and Service should be developed that removes the threats to Arizona cliffrose and provides for its recovery. The Service should develop conservation agreements or easements with private landowners that will also remove threats and contribute to recovery. These should be coordinated with neighboring private landowners or public land management agencies.
2. Initiate research and other actions needed to monitor the species' status and guide recovery efforts. Best management efforts are guided by good biological and ecological information. Currently, too little is known about Arizona cliffrose to determine the most appropriate management actions to

effect recovery and determine population stability. Research, studies, and other actions are needed to provide a sound basis for management.

2a. Refine species description. Although significant progress towards refining the description of *Purshia subintegra* has been made in recent years, additional clarification may be helpful. Additional DNA analysis and other objective techniques plus further field investigations combined with a better understanding of the ecology of this species will help biologists and managers understand its classification and evolutionary history.

2b. Conduct surveys and inventories to define potential habitat, range, circumscribe recovery units, and quantify abundance and density. Further state-wide surveys should be conducted to refine the range of the species. Many surveys for Arizona cliffrose have already been conducted, but new populations or subpopulations may yet be discovered. Surveys should occur for specific Federal agency project clearances and section 7 consultations. Proactive surveys unassociated with projects should also occur. Aerial photos and Soil and Terrestrial Ecosystem Surveys prepared by the Soil Conservation Service may help to identify potential habitat.

Each population and its subpopulations should be accurately mapped. Maps that accurately describe the known locations of the Cottonwood and Burro Creek populations are available, but more complete inventories are needed in the Verde Valley and in suitable habitat near the known Burro Creek population. Additional surveys are needed to accurately define the extent of the Horseshoe Lake and Bylas populations.

Populations and subpopulations should be inventoried to quantify the existing population with statistical accuracy and assess habitat quality. Methods should be developed that can withstand the critical review of appropriate experts. Although the quantitative inventory can be made using relatively objective methods, an assessment of habitat quality will necessarily be somewhat subjective and descriptive. For example, low densities of Arizona cliffrose may be an expression of poor habitat quality, prior disturbance, or both of these or other factors. High quality or priority areas to be mapped should include, but not be limited to, areas that support or could support high densities of Arizona cliffrose plants, that have been relatively undisturbed, that support other rare species, that are protected by a management agreement, or that have active recruitment occurring. This information is needed to set management and protection priorities.

Information gained from these surveys should be managed and maintained by the Arizona Game and Fish Department Heritage Data Base and/or other suitable system.

- 2c. Develop and implement a monitoring program to determine the population dynamics of each recovery unit. This monitoring program should determine if each recovery unit contains sufficient Arizona cliffrose individuals to sustain a viable population or one that demonstrates an upward trend for 15 years. Methods should be developed that can withstand the critical review of appropriate experts and will achieve Recovery Criteria 1.

Because mature Arizona cliffrose plants appear to have a relatively low mortality rate, the older age classes of each cliffrose population may

need to be monitored less frequently than the younger age classes. The younger age classes, having higher mortality, will need to be monitored more intensively and with a higher frequency. Seedling survivorship may need to be studied weekly during the seedling emergence period. After the establishment period, monthly or yearly monitoring may be adequate. Monitoring younger age classes should be a priority because of the relative importance of the contribution of these age classes to population increases and stability.

2d. Describe the life history characteristics of the species. An evaluation of population dynamics must be based on life history traits. Some of these traits, such as age/size of first reproduction, number of seeds produced per year, and reproductive output, will be difficult to quantify. The longevity of plants contributes to this difficulty, as do site differences and annual/seasonal weather variability. Certain traits may vary from year to year, among populations, or among microsites. However, some data can be collected that will help us understand the population dynamics and ecology of Arizona cliffrose.

2d.1. Determine seed germination and seedling establishment requirements. Greenhouse experiments should be conducted that will determine percent seed viability and conditions under which seeds germinate and seedlings successfully establish. Field experiments to determine *in situ* rates of germination and establishment should also occur. These experiments are needed to determine if recruitment sufficient to maintain or increase population size is occurring in each population. Testing should occur at each recovery unit and in different years, to describe variability.

2d.2. Determine reasons for what appears to be differential recruitment rates among recovery units. Some parts of the Cottonwood population appear to be actively reproducing, while other parts do not. The other three populations have recruitment that appears insufficient to maintain or increase population size. Enhancing the habitat features that are necessary to support sufficient recruitment may be the key to Arizona cliffrose recovery but they are currently unknown.

2d.3. Age plants and determine growth rates. Without causing death, damage, or disease, determine the age of mature, existing individuals. Aging may be done through tree-ring analysis on plants that have been salvaged from destruction. Plants that are salvaged and aged should be measured before salvage occurs so that a data base can be built to determine if plant size relates to age.

In each recovery unit, design and implement a monitoring system that will track growth of seedlings from establishment. Information about seedling growth and age to sexual maturity is needed to determine if the population is stable.

2e. Develop or refine propagation techniques. Small projects that may cause the loss of plants without severe surface or soil disturbance in Arizona cliffrose habitat have occurred and could occur again. The potential for restoring Arizona cliffrose to these habitats should be explored. Experiments to determine if Arizona cliffrose can be successfully propagated *ex situ* should occur. If successful propagation is possible, then transplantation to disturbed areas should be attempted

using scientifically controlled, experimental methods. If plants can be successfully restored to disturbed habitat, restoration should be considered as mitigation for projects having adverse effects. However, restoration will not be considered as appropriate ecosystem management. At this time, restored areas will not contribute towards recovery because their long-term stability will be untested and therefore unknown.

- 2f. Describe pollination biology and ecology and determine the identity and role of other insects affecting Arizona cliffrose. The pollination biology work begun by the U.S. Department of Agriculture Bee Biology Lab (Fitts *et al.* 1992) should be continued. Pollinators of Arizona cliffrose should be identified in each recovery unit and the ecology of the species described. Whether or not fruit production is limited by pollinators should be determined. All other insects that depend on or use Arizona cliffrose should be determined and their role in Arizona cliffrose population maintenance should be identified.
- 2g. Initiate research on effects of season of livestock grazing and duration of grazing on the growth and reproduction of Arizona cliffrose. The recovery plan currently recommends fall-winter grazing. However, a different season of use may have fewer adverse effects on Arizona cliffrose and its habitat. Further study is needed to determine the season of use that will reduce or remove adverse effects.
- 2h. Identify other appropriate research needed to facilitate recovery. The status of Arizona cliffrose and its threats should be periodically reviewed and new research and management actions identified as appropriate.

3. **Eliminate or minimize threats to the species.** Threats which prevent the recovery of Arizona cliffrose should be eliminated. The most important current threats to Arizona cliffrose are habitat loss due to mineral exploration and development, urbanization, recreation, roads, and utilities, and habitat degradation due to livestock grazing and recreation. Reducing or eliminating these and all other threats will lead to the recovery of Arizona cliffrose.

3a. **Manage mineral exploration and development.** Mineral exploration and development is currently the most important threat to the Burro Creek population and has significantly affected the population in the past. Mining claims exist at the other three sites, but mining activity has been limited. Preventing habitat loss and degradation due to mineral exploration and development will play a critical role in the recovery of Arizona cliffrose.

3a.1. **Manage projects requiring Mining Plans of Operations (MPOs).** The BLM has developed implementing regulations for the 1872 Mining Act, which are slightly different from the Forest Service implementing regulations. The BLM implementing regulations require operators to file Mining Plans of Operation (MPO) when they plan to create or expand a mine or conduct mineral assessment or exploration work that exceeds five acres. A MPO is also required for projects under 5 acres (2.0 hectare) on BLM lands within designated special management areas such as ACECs or Botanical Areas.

On National Forest Service lands, a MPO for locatable minerals is required when the District Ranger determines that the

proposed operation "will likely cause significant disturbance of surface resources" [36 CFR § 2284.(a)].

The BLM or other Federal surface management agency can not refuse to issue a permit, but must add stipulations that will bring the action into compliance with Federal laws, including the Endangered Species Act. Permit stipulations can be used to minimize adverse effects to Arizona cliffrose and its habitat, and are usually project-specific. Development of alternatives as required by the National Environmental Policy Act will provide an opportunity to limit adverse effects and restore habitat after the action is complete. Alternatives and permit stipulations that should be considered include, but are not limited to:

- Placing supporting facilities, such as access roads and buildings, where the amount of habitat lost or disturbed is minimized. Consider moving certain facilities off-site.
- Requiring operator to post a bond for reclamation work.
- Requiring operator to hire a qualified botanist to monitor work.
- Designing the project to facilitate reclamation.
- Developing compensatory schemes.

3a.2. Manage projects not requiring MPOs. When mining or mineral assessment work is planned that is under 5 acres (2 hectare) and is not within an ACEC, Botanical Area, or other special management area, the BLM implementing regulations do not require a MPO. However, the operator must file a Mining Notice with the BLM and comply with applicable law, including the

Endangered Species Act. The BLM or other surface management agency should encourage the operator to file a MPO and comply with stipulations provided by the agency.

3a.3. Permanently protect Arizona cliffrose habitat from mining.

Withdraw Arizona cliffrose habitat from mineral entry and mineral leasing and do not allow mineral material disposals. Withdrawals would preclude any future exploration except on valid existing claims. Voluntary relinquishment of mining claims should be sought.

3b. Protect Arizona cliffrose from adverse effects of livestock grazing.

Arizona cliffrose is known to be a palatable species, and can be heavily used, particularly in areas with water sources nearby. Appropriate stocking rates and grazing systems should be applied to prevent moderate to heavy grazing within Arizona cliffrose habitat. If the permitted livestock grazing can not meet the criteria in 3b.1, 3b.2, and 3b.3, then exclusion of livestock should occur.

3b.1. Develop or revise and implement AMPs. AMPs that address livestock grazing in Arizona cliffrose habitat should be developed or revised and implemented. These AMPs should include the following criteria:

- Key forage species should include preferred palatable species.
- Livestock utilization of Arizona cliffrose should be permitted only if the combined use by livestock and wildlife does not exceed 20% of current year's growth for any individual. Utilization of Arizona cliffrose should

be measured each year livestock are within pastures containing Arizona cliffrose.

- Livestock should be permitted within pastures containing Arizona cliffrose only during the fall and early winter months (October through January), when cliffrose is not actively growing, current year's growth is not fresh, and most seedlings are not emerging. If studies determine a different season of use would have less effect on Arizona cliffrose, a change should be considered and implemented if appropriate.
- Livestock should not be permitted to use pastures containing Arizona cliffrose more frequently than once every two years.
- The potential natural community for Arizona cliffrose habitat at each site should be defined. AMPs should be designed to reach this potential natural community and implemented.
- Management techniques should be applied that will avoid areas of moderate to heavy utilization within Arizona cliffrose populations and habitat. No loading areas, salt blocks, mineral or nutrient supplements, or watering facilities for cattle should be placed within 0.5 mile (0.8 km) of an Arizona cliffrose population. Existing watering, salting, and loading facilities should be moved at least 0.5 mile away. Distances between Arizona cliffrose populations and livestock facilities may need to be larger than 0.5 mile if African breeds of cattle are within the pasture.

- Goats or sheep should not be permitted within pastures containing Arizona cliffrose. Goats and sheep often travel farther away from water and over rougher terrain than can cattle. Their browsing habits present a greater threat to Arizona cliffrose than do cattle.

AMPs that do not meet these criteria should be revised.

- 3b.2. Continually review utilization, condition, and trend. Adjust stocking rates and grazing systems as necessary. Cattle may need to be excluded if criteria in 3b.1 are not met. Exclusion or rest may also be necessary if current condition is poor or fair and trend is stable, recruitment rates of Arizona cliffrose are adversely affected by grazing, condition and trend are not meeting recovery goals, or if plant vigor is low. Review of data should occur at least once per year.
- 3b.3. Grazing decisions should comply with section 7 of the Act. Formal section 7 consultation should occur when Federal agencies conduct, permit, or carry out an action that may adversely affect Arizona cliffrose. The effects of term grazing permits and management documents including AMPs should be assessed and formal section 7 consultation should be conducted as appropriate. Term grazing permits and/or AMPs may need to be adjusted if permitted use do not meet the criteria 3b.1 and 3b.2.
- 3b.4. Maintain the enclosure fence surrounding the Burro Creek population to control burro/livestock browsing. The enclosure

fence should be checked at least once a year and always before livestock are turned out into the pasture containing or adjacent to the enclosure. These tasks should be conditions on the term permit.

- 3b.5. Provide educational opportunities to livestock operators. Livestock operators should be trained to identify Arizona cliffrose and its habitat and management requirements. Federal agencies should help operators understand how the Endangered Species Act works and why compliance is important.

3c. Urbanization. The most important threat to the Cottonwood population of Arizona cliffrose is urbanization. Urbanization causes permanent loss of habitat. To minimize habitat loss due to urbanization, permanent protection of habitat is necessary.

- 3c.1. Use land exchanges to benefit Arizona cliffrose. The Federal government has the ability to exchange federally-owned lands with private landowners when it benefits the public interest. The Federal government should use opportunities to acquire lands containing Arizona cliffrose populations. Land exchanges that will transfer Federal lands containing Arizona cliffrose populations out of Federal ownership into private or state ownership should be avoided. Particularly in the Cottonwood area, privately owned land is likely to be developed, and Arizona cliffrose significantly impacted. If in the future, the Arizona State Land Department is permitted to conduct land exchanges with the Federal government, opportunities to consolidate Arizona cliffrose habitat into Federal ownership should be used.

- 3c.2. Provide permanent protection from urbanization. Lands not under Federal ownership should be permanently protected through conservation easements or other binding methods. Another option for permanent protection is to use all opportunities to consolidate Arizona cliffrose habitat into Federal ownership.
- 3d. Eliminate or reduce habitat loss or degradation caused by roads, trails, and utilities. The construction of roads, trails, and utilities has caused significant loss and degradation of Arizona cliffrose habitat.
- 3d.1. Do not permit or construct new roads, recreational trails, or utility rights-of-way through habitat. No new roads, trails, utilities or other uses should be permitted or constructed through or within 0.2 km (1/8 mile) from an Arizona cliffrose population, but should be routed around occupied habitat.
- 3d.2. Evaluate and reduce the effects of existing facilities. Existing paved roads are few and currently there is no need to re-route or remove them. However, the Arizona Department of Transportation and other agencies responsible for road maintenance should develop plans, policies, and education programs to eliminate vegetation removal and herbicide applications in rights-of-way within Arizona cliffrose populations.

The need for all existing dirt roads and recreation trails through occupied Arizona cliffrose habitat should be reviewed. Roads and trails that have no demonstrated public or administrative need should be closed and rehabilitated. Most jeep roads should

be closed and restored, or should remain open only to administrative use, gated and locked. Keeping some dirt roads open may be appropriate. An example of such a road might be the road through the Burro Creek population, sometimes referred to as the Signal Road or Six-Mile Crossing Road.

Road closures should be indicated by fences, signs, or other effective methods. The closures should be strictly enforced using State and Federal laws. Enforcement will be particularly important and likely the most difficult shortly after the closures have been posted.

Where practicable, habitat formerly disturbed by existing utilities should be restored. Experimental plantings of Arizona cliffrose and associated plant species should be attempted (see recovery task 2e).

- 3e. Eliminate or minimize adverse recreation effects. Recreation is having significant adverse effects in the Cottonwood population. Adverse effects are expected to increase as the nearby urban population increases. Control or elimination of adverse recreation effects will be critical to achieving recovery for this recovery unit. Recreation impacts should be monitored in other populations, and appropriate management responses taken.

- 3e.1. Eliminate or minimize adverse effects of recreation facilities. No new recreation facilities, such as campgrounds, should be constructed within 0.8 km (0.5 mile) of Arizona cliffrose populations. All existing recreation facilities should be reviewed to determine effects. If proposed or existing facilities on Federal

lands may adversely affect Arizona cliffrose, formal section 7 consultation should occur.

- 3e.2. Eliminate the informal shooting range in the Cottonwood population. The shooting range within the Cottonwood population north of Rocking Chair Road should be closed and habitat restored. The shooting range is located in Township 15 North, Range 3 East, section 1. Natural resources at the site, including the Arizona cliffrose population, are severely degraded. Soil compaction and erosion are a problem. Public safety may also be an issue; shooting is occurring within a short distance of private homes and less than 0.4 km (1/4 mile) away from a well-travelled paved road.
- 3e.3. Prohibit ORV traffic within Arizona cliffrose recovery units. Excluding ORV traffic may involve constructing fences and locked gates, placing signs to indicate ORV exclosures, or other methods needed to effectively control use. If fences are constructed, they should not divert ORV use from areas that are currently used to areas where there was no previous use or light use. Post State trust land to indicate no trespassing and notify people that the habitat is protected by the Arizona Native Plant Law.
- 3e.4. Educate ORV user-groups. Meet with local ORV user-groups to inform them of the prohibitions. Create and distribute information pamphlets to local ORV merchants informing user-groups of local road closures and use prohibitions.

3f. Identify browsers other than livestock and ways to control any adverse effects to Arizona cliffrose and its habitat. Arizona cliffrose is palatable to burros and wildlife and may be exceeding sustainable levels near Horseshoe Lake. Where wildlife utilization may be exceeding sustainable levels, studies should be conducted to identify the browsing species, determine if adverse effects are occurring, and, if so, implement control measures.

3g. Protect populations from pesticide and herbicide applications. Appropriate buffer zones to protect Arizona cliffrose from pesticides and herbicides should be implemented through the Environmental Protection Agency (EPA) pesticide registration and labelling program. All pesticides used in the United States must be registered with the EPA. This registration program is subject to Federal laws, including the Endangered Species Act. Section 7 consultation should occur on the registration of all pesticides and herbicides that may be used within or near Arizona cliffrose habitat. EPA could work towards achieving its affirmative responsibility to recover listed species by ensuring that buffer zones are provided to Arizona cliffrose populations to prevent adverse effects.

Until information is gathered about all insects beneficial to Arizona cliffrose, the effects of general pesticide applications within Arizona cliffrose populations or less than 4.8 km (3 miles) from known populations will be considered adverse. No aerial applications of general pesticides should occur within a minimum of 4.8 km (3 miles) of Arizona cliffrose populations. Ground application of pesticides will be considered on a case-by-case basis. Other forms of pest control should be considered as alternatives to chemical controls.

Use of herbicides should be avoided within known populations and their immediate watersheds.

- 3h. Prevent habitat loss due to inundation. Expansion of Horseshoe Lake and construction of new dams that would inundate habitat should be avoided.
4. Enforce and apply existing laws and regulations. Full use of all Endangered Species Act regulatory control should be used to manage and protect Arizona cliffrose populations. Arizona State law should also be applied and enforced.
- 4a. Continue to provide the protection of Arizona State law. The protections offered by the Arizona Native Plant Law should remain in place. The Native Plant Law provides protections to Arizona cliffrose in addition to the protections provided by the Endangered Species Act. Section 9 of the Endangered Species Act provides protection against removal, cutting, digging up, damaging, or destroying any listed species if such actions occur off Federal lands and in knowing violation of State law, including the Arizona Native Plant Law.
- 4b. Patrol Arizona cliffrose population in Cottonwood area to eliminate ORV use. ORV users on Arizona State Trust land in the Cottonwood area without access permits from the Arizona State Land Department may be in violation of the Arizona Native Plant Law and State trespass law and may be damaging Federal government property. If ORV users are in violation of State law, they are also in violation of the Endangered Species Act. In addition to the fencing and signing mentioned in recovery task 3e.3, aggressive enforcement of State and Federal laws

should be pursued. Aggressive enforcement will be needed to control and contain ORV use in the Cottonwood area.

- 4c. Designate critical habitat if found prudent and determinable. Re-evaluate the original determination that the designation of critical habitat was not prudent for Arizona cliffrose to decide if the determination should be changed based on additional knowledge of the species. If designation is found prudent, use information from recovery task 2b to identify areas to be so designated.
- 4d. Vigorously enforce conditions of term grazing permits and allotment management plans. Federal agencies issuing term grazing permits and signing AMPs and National Environmental Policy Act documents should ensure that permit conditions and AMPs are being carried out. If these conditions are not met, the Federal agency should review the need to initiate or reinstate formal section 7 consultation.
5. Information and education. Exchange of information and ideas among private landowners, the scientific community, the public, and Federal, State and local agencies is essential to a successful recovery program. Scientific information, including results of field and greenhouse research, monitoring data, trip reports, agency reports, and scientific literature should be readily available to all parties interested in the management and survival of Arizona cliffrose. Ideas should be freely exchanged so that optimal recovery strategies can be outlined and implemented. Meetings of interested parties to discuss new information or management issues or strategies should be encouraged. Preliminary or refined research or monitoring data should be presented at local, regional, and national gatherings of professional scientists so that a broad professional audience may have opportunities to comment on, and potentially enhance, recovery of Arizona cliffrose.

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PART III - IMPLEMENTATION SCHEDULE

The following implementation schedule outlines actions and costs for the Arizona cliffrose recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. The schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of Arizona cliffrose and protect its habitat. It should be noted that estimated monetary needs for all parties involved in recovery are identified for the first three years only, and therefore are not reflective of total recovery costs. An estimate of total costs to reach the downlisting objective for this species is provided in the EXECUTIVE SUMMARY, page iii. Costs are estimated to assist in planning. This recovery plan does not obligate any involved agency to expend the estimated funds. Though work with private landowners is called for in the plan, landowners are not obligated to expend any funds.

Task Priorities

- Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 1* - An action that by itself will not prevent extinction or an irreversible decline, but which is needed to carry out a task that is a priority 1 task, as defined above.
- Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality, or some other negative impact short of extinction.
- Priority 3 - All other action necessary to meet recovery objectives.

Responsible Party Abbreviations

FWS -	U.S. Fish and Wildlife Service
	ES- Ecological Services Office
CNF -	Coconino National Forest
TNF -	Tonto National Forest
BLM -	Bureau of Land Management
BIA -	Bureau of Indian Affairs
USBR -	Bureau of Reclamation
SCA -	San Carlos Apache Tribe
ADOT -	Arizona Department of Transportation
AZSL -	Arizona State Land Department
ADA -	Arizona Department of Agriculture

Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates (\$,000s)			Comments
				FWS		Other	Year 1	Year 2	Year 3	
				Region	Program					
1	1a	Develop conservation strategy on SCIR	2	2	ES	BIA SCA	2.0 3.0 3.0	2.0 3.0 3.0	-0- -0- -0-	
1	1c,1g	Develop conservation strategies/agreements on Federal, State and private lands	2	2	ES	BLM CNF TNF AZSL	5.0 5.0 6.0 5.0 5.0	5.0 5.0 6.0 5.0 5.0	-0- -0- -0- -0- -0-	
1	2c	Monitor population dynamics	15	2	ES	BLM CNF TNF SCA	4.0 10.0 10.0 10.0 10.0	2.0 6.0 6.0 6.0 3.0	2.0 6.0 6.0 6.0 3.0	
1	3a.1 3a.2	Manage mining projects	Ongoing	2	ES	BLM CNF TNF	1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0	
1	3a.3	Permanently protect from mining	Ongoing	2	ES	BLM CNF TNF	0.5 0.5 0.5 0.5	0.5 0.5 0.5 0.5	0.5 0.5 0.5 0.5	
1	3b.1	Develop, revise, and implement AMPs	Ongoing	2	ES	TNF CNF BLM	1.0 4.0 1.0 1.0	1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0	
1	3b.2	Review grazing use	Ongoing	2	ES	BLM CNF TNF	-0- 1.0 1.0 1.0	-0- 1.0 1.0 1.0	-0- 1.0 1.0 1.0	
1	3b.4	Maintain exclosure fence at Burro Creek	Ongoing	2	ES	BLM	-0- -0-	-0- -0-	-0- -0-	
1	3c.2	Permanently protect from urbanization	Ongoing	2	ES	AZSL	-0- unknown	-0- unknown	-0- unknown	
1	3d.1	Construct no new roads, trails or utilities	Ongoing	2	ES	BLM BIA CNF TNF	-0- -0- -0- -0-	-0- -0- -0- -0-	-0- -0- -0- -0-	

Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates			Comments
				FWS		Other	Year 1	Year 2	Year 3	
				Region	Program					
1	3e.1	Eliminate or reduce threats from recreation	Ongoing	2	ES	BLM CNF TNF	-0- 5.0 5.0 0.5	-0- 0.5 0.5 0.5	-0- 0.5 0.5 0.5	
1	3e.2	Remove shooting range & restore habitat	3	2	ES	CNF	-0- 10.0	-0- 8.0	-0- 8.0	
1*	2b	Conduct surveys	2	2	ES	SCA CNF TNF BLM	-0- 5.0 5.0 4.0 4.0	-0- 5.0 -0- 4.0 4.0	-0- -0- -0- -0-	
1*	2d	Describe life history characters	10	2	ES	BLM CNF TNF SCA	1.0 8.0 8.0 8.0 8.0	1.0 8.0 8.0 8.0 8.0	1.0 8.0 8.0 8.0 8.0	
1*	2d.1	Study seed germination & seedling establishment requirements	3	2	ES	BLM CNF TNF SCA	-0- 4.0 4.0 4.0 4.0	-0- 4.0 4.0 4.0 4.0	-0- 4.0 4.0 4.0 4.0	
1*	2d.2	Contrast recruitment rates between populations	15	2	ES	BLM CNF TNF SCA	5.0 2.0 2.0 2.0 2.0	5.0 2.0 2.0 2.0 2.0	5.0 2.0 2.0 2.0 2.0	Majority of cost imbedded in task 2c
1*	2d.3	Determine growth rates	15	2	ES	BLM CNF TNF SCA	15.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0	Majority of cost imbedded in task 2c

Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates			Comments
				FWS		Other	Year 1	Year 2	Year 3	
				Region	Program					
1*	4d	Enforce grazing permits	Ongoing	2	ES	BIA BLM CNF TNF	-0- 0.5 0.5 0.5 0.5	-0- 0.5 0.5 0.5 0.5	-0- 0.5 0.5 0.5 0.5	
2	1b	Designate special management areas	2	2	ES	BLM CNF TNF	-0- 0.5 0.5 2.0	-0- 0.5 -0- 1.0	-0- -0- -0- -0-	
2	2a	Refine taxonomy	3	2	ES		20.0	20.0	-0-	
2	2f	Describe plant/insect interactions	3	2	ES		10.0	10.0	10.0	
2	3b.3	Grazing decisions/section 7 compliance	Ongoing	2	ES	BIA BLM CNF TNF	-0- 1.5 -0- -0- 1.5	-0- -0- -0- -0- -0-	-0- -0- -0- -0- -0-	
2	3c.1	Land exchanges	Ongoing	2	ES	CNF	-0- -0-	-0- -0-	-0- -0-	
2	3d.2	Reduce effects of existing roads, recreation, and utilities	2	2	ES	BLM CNF TNF ADOT	-0- 1.0 1.0 1.0 1.0	-0- -0- -0- -0- -0-	-0- -0- -0- -0- -0-	
2	3e.3	Prohibit ORV use	Ongoing	2	ES	BLM CNF AZSL ADA	-0- 2.0 20.0 -0- 0.5	-0- -0- -0- -0- -0-	-0- -0- -0- -0- -0-	
2	3e.4	Educate ORV users	Ongoing	2	ES	CNF	1.0 0.5	-0- 0.5	-0- 0.5	
2	3f	Study wildlife browsing	2	2	ES	TNF	-0- 4.0	-0- 4.0	-0- -0-	

Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates			Comments
				FWS		Other	Year 1	Year 2	Year 3	
				Region	Program					
2	4a	Enforce AZ state laws	Ongoing	2	ES	ADA	-0-0.5	-0-0.5	-0-0.5	
3	2e	Develop propagation techniques	3	2	ES		6.0	6.0	6.0	
3	3b.5	Educate livestock operators	Ongoing	2	ES	BIA SCA BLM CNF TNF	-0-0.5 0.5 0.5 0.5 0.5	-0-0.5 0.5 0.5 0.5 0.5	-0-0.5 0.5 0.5 0.5 0.5	
3	3h	Prevent inundation	Ongoing	2	ES	USBR	-0-0- -0-	-0-0- -0-	-0-0- -0-	
3	4b	Patrol habitat, Cottonwood	Ongoing	2	ES	ADA CNF	-0-0-0.5 -0-0.5	-0-0-0.5 -0-0.5	-0-0-0.5 -0-0.5	ADA cost included in task 4a
3	4c	Designate critical habitat	2	2	ES		20.0	50.0	-0-	
3	5	Information & education	Ongoing	2	ES		1.0	1.0	1.0	
TOTAL							307.0	256.0	135.5	

APPENDIX**Summary of Comments Received
on the Draft Arizona Cliffrose Recovery Plan
and Service Responses**

On February 15, 1994, a Federal Register notice announced that the draft Arizona Cliffrose Recovery Plan was available for public review. The Service accepted comments on the draft plan between February 14, 1994, and April 18, 1994. The draft recovery plan was distributed to 193 agencies and individuals. Comments were received from the following parties:

Regional Forester, U.S. Forest Service, Region 3, Albuquerque, New Mexico
State Director, Bureau of Land Management, Arizona State Office, Phoenix, Arizona
Project Manager, Arizona Projects Office, Bureau of Reclamation, Phoenix, Arizona
Dr. David Mount, Department of Molecular and Cellular Biology, University of Arizona, Tucson, Arizona
Mike Seidman, President, Central Arizona Chapter, Society for Conservation Biology, Arizona State University, Department of Zoology, Tempe, Arizona
Frank Reichenbacher, Southwestern Field Biologists, Tucson, Arizona
Margaret Thede, Cornville, Arizona
Joyce Maschinski, Curator of Plants, Transition Zone Horticultural Institute, Flagstaff, Arizona
Richard Thompson, Chairman, Verde Natural Resource Conservation District, Cottonwood, Arizona
Amelia Jashulski, Sedona, Arizona
Conservation Chairman, Maricopa Audubon Society, Phoenix, Arizona
Brian S. Mickelsen, City Manager, City of Cottonwood, Arizona
Carlos D. Ronstadt, Snell and Wilmer Law Offices, Phoenix, Arizona (comments on behalf of the Bar T Bar Ranch Company)
Bob Denham and Norine Fobes, Cottonwood, Arizona
Robert A. Johnson, Chandler, Arizona
Donna Howell, Tucson, Arizona

All comments were considered when revising the draft plan. The Service appreciates the time each of the commentors took to review the draft and to submit their comments.

The comments discussed below represent a composite of those received prior to the close of the public comment period. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or financial needs identified in the draft plan or suggest changes to the draft plan are discussed here. Editorial corrections, such as better wording, measuring unit equivalency, or spelling and punctuation changes, were incorporated as appropriate without discussion here. Specific comments that were directed at other reports, such as Mount and Logan (1993) and Reichenbacher (1993), were not addressed.

All comments received are retained as part of the administrative record of recovery plan development. This administrative record is held at the Arizona Ecological Service State Office, Phoenix.

Comment: Has the Service considered the possibility that Arizona cliffrose is declining for reasons other than human impacts?

Response: The Service has considered this possibility and believes that Arizona cliffrose could decline over the next several thousand years due to post-glacial changes in climate and vegetation. The Endangered Species Act is not intended to manage those types of declines but rather human-caused declines. We believe that human impacts are the primary cause for the short-term decline and loss of vigor documented in the Arizona cliffrose populations. These threats are identified in detail in the recovery plan.

Comment: Is the Service certain that Arizona cliffrose is declining and not simply a rare, specialized species?

Response: The Service believes the Arizona cliffrose is declining for the reasons discussed in the text of the recovery plan: livestock and burro use causing poor plant vigor and reproduction, recreation, pesticides, and loss of habitat due to mineral exploration and development, off-road vehicle use, construction and maintenance of roads and utilities, urbanization, and inundation. It is also a rare, specialized species.

Comment: Could the species be declining because population sizes are small and genetic variability is limiting? Could lack of genetic variability have caused a problem with recruitment?

Response: The available information indicates that the probability of extirpation due to demographic stochasticity is low. In his preliminary examination of the

genetic diversity of all four Arizona cliffrose populations, Mount (1993) found a high degree of genetic variability within and between Arizona cliffrose populations.

Comment: Page 22 of the draft recovery plan states that certain areas of the Cottonwood population are reproductive. This statement seems to conflict with page 57, which states that the whole population is actively reproducing.

Response: The first statement is correct. The text has been changed.

Comment: Please include former scientific names of *Purshia subintegra*, a comparison of the genera *Purshia* and *Cowania*, and a discussion of why *Cowania subintegra* was changed to *Purshia subintegra*.

Response: The most commonly accepted former name for *Purshia subintegra* was *Cowania subintegra*. The final recovery plan has been amended to include this name. Henrickson (1986) explains his reasoning for combining the two genera *Cowania* and *Purshia*. The Service does not believe it is necessary to repeat his discussion nor present a thorough taxonomic treatise in this recovery plan.

Comment: Recovery plans are exercises in futility and a waste of taxpayer money.

Response: The Endangered Species Act requires the Service to prepare recovery plans for all endangered and threatened species, unless the Service finds that a recovery plan will not promote the conservation of the species (section 4(f)(1)). The Service has determined that a recovery plan for Arizona cliffrose will promote its conservation. The Tonto National Forest, Coconino National Forest, and Arizona State Land Department have already begun implementing some of the tasks recommended in the draft recovery plan. These positive actions support the Service's determination that a recovery plan will enhance recovery of this species.

Comment: It is in error to state that *Larrea tridentata* is nearly absent where *Purshia subintegra* occurs in the Verde Valley. The two species are frequently associated.

Response: *Larrea tridentata* and *Purshia subintegra* both occur on the Verde Formation in the Verde Valley. Where *Purshia subintegra* occurs, *Larrea tridentata* generally does not. Soil characteristics appear to be the primary factor determining the separate distribution of the two species.

Comment: *Canotia holacantha* is not a characteristic Sonoran Desert species.

Response: Although not certain, the Service presumes that the commentor is asking that the characterization of *P. subintegra* habitat be discounted as the *Larrea tridentata* - *Canotia holacantha* Association of the Arizona Upland Subdivision of the Sonoran Desertscrub. The Service cannot accept this recommendation. The Service is following the vegetation classification system of Brown (1982), which is the standard reference for the classification of Arizona biotic communities. We have included *C. holacantha* in the habitat characterization of *P. subintegra* because *C. holacantha* is an associate of *P. subintegra* at all four sites.

Comment: All references to insufficient reproduction should be removed from the plan because they are purely speculative.

Response: The Service does not currently have the demographic data to precisely determine the level of recruitment sufficient to maintain Arizona cliffrose populations over the long term. Collection of such data is recommended in the recovery plan. The current lack of conclusive data does not preclude the assumption or hypothesis that recruitment is insufficient at some sites. The skewed age/size class distribution of the Burro Creek population observed by several botanists is sufficient evidence to presume that recruitment is less than the rate needed for the long-term maintenance of the population.

Comment: If the amount of habitat loss in the Cottonwood area has not been estimated, how is it known that a significant amount of habitat loss has occurred?

Response: The presence of roads, homes, and other buildings within or adjacent to occupied *P. subintegra* habitat is enough evidence for the Service to conclude that habitat loss has occurred. Given the relatively small amount of occupied habitat in the Cottonwood area, the Service believes the amount of habitat already lost is significant.

Comment: The point of paragraph 1, page 49, of the draft recovery plan is not clear.

Response: We have clarified the paragraph.

Comment: The species is not declining anywhere except very locally and only due to direct habitat loss.

Response: The Service does not believe Arizona cliffrose is declining only locally and that direct habitat loss is its only threat. The magnitude and diversity of threats are discussed in the recovery plan.

Comment: No data are presented to show the precise, or even approximate, effect of direct habitat losses on the overall population.

Response: The recovery plan recommends precise mapping of disturbed, undisturbed, and destroyed habitat. These maps will help us determine the effect of direct habitat losses on each population. Meanwhile, the Service will have to subjectively estimate the amount of habitat loss, as needed and as appropriate.

Comment: The recovery plan should require that surveys be conducted to document the extent and abundance of the plant.

Response: The draft and final recovery plans recommend that such surveys be conducted by land management agencies (recovery task 2b).

Comment: Two additional populations of Arizona cliffrose exist: one near Jerome and another near the confluence of Oak Creek and the Verde River. They are not identified in the recovery plan.

Response: The Service is aware of these two sites, which support populations of *Purshia stansburiana*, not *Purshia subintegra*, and therefore are not mentioned in the plan.

Comment: The Cottonwood population has been severely impacted by off-road vehicle use. The Service should place a high priority on working with appropriate land management officials to stabilize and reverse degradation of the area.

Response: The Coconino National Forest is developing a management plan for the Arizona cliffrose habitat that will address the off-road vehicle damage, which is occurring primarily on the Coconino National Forest. The Service is working cooperatively with the Forest on this issue.

Comment: The Service underestimated the cost of education efforts, particularly in the second through fourth year of plan implementation.

Response: The Service agrees that the cost was underestimated and has changed the estimate. We emphasize that the costs identified in the

implementation schedule are only estimates; actual costs may be less than or greater than the estimated amount.

Comment: The Verde Natural Resource Conservation District (VNRCD) supports the scope and objectives of the recovery plan and is would like to discuss a partnership with the Service and the VNRCD Conservation Education Center regarding planning and/or administration of the proposed education program.

Response: The Service appreciates the support of the VNRCD and will investigate the possibility of a cooperative education program.

Comment: The recovery plan should specifically mention a proposal (with literature cited) to extend Mingus Avenue in Cottonwood. The new road and bridge are identified as future projects in the Cottonwood and Verde Valley regional transportation plans.

Response: The Service is aware that the project is being actively discussed and surveys have been conducted. The Service chose to identify classes or general descriptions of future threats and not specific future actions unless those actions were in the Federal planning stage and were funded. The Mingus Avenue extension has not been funded, nor has the NEPA planning process been initiated. Therefore, the Service considers the project a possibility, but not a current threat.

Comment: The recovery plan recommends landowners and land management agencies prepare management plans for *Purshia subintegra* populations occurring on lands they manage. Because we do not know what these plans will recommend or require, we find it difficult to understand how land use will be affected.

Response: The Service does not have the authority to direct, through recovery plans, the management decisions of Federal or State agencies, or private landowners. Recovery plans state the Service's management goals, recommended actions, and priorities. During the comment period on each recovery plan, the Service hopes to obtain input from public land managers and owners that will help develop a recovery plan that is consistent with the goals, actions, and priorities of all affected parties. All Federal agencies are required to conserve threatened and endangered species. It is the desire of the Service that non-Federal agencies and individuals work with the Service through habitat management plans and other avenues available to provide the emphasis necessary to recover threatened and endangered species.

Comment: The recovery plan should encourage the Coconino National Forest to make withdrawals identified in the Forest Plan a high priority.

Response: The recovery plan recommends that withdrawals take place (recovery task 3a.3), but the Service does not have the authority to prioritize work items for another Federal agency.

Comment: Why cite Denham and Fobes 1992 a, b, c, e, separately when it is one report?

Response: The reports are separate entities bound in one volume. For that reason and for the ease of the reader, the Service chose to cite them separately.

Comment: Throughout the document, add Prescott National Forest when discussing the Verde Valley population. Although no populations are known on that Forest, potential habitat occurs there. The recovery plan should apply to the Prescott National Forest.

Response: If populations of *P. subintegra* are found on the Prescott National Forest, the recovery plan will apply to those populations. Recommendations have been added to the recovery outline extending the recovery plan to populations discovered after this plan is issued. If a significant number of new populations are discovered, the Service will review the appropriateness of the recovery plan and the species' listing status and make changes if warranted.

Comment: The Service relies too much on unpublished reports, annotations, and observations to support management decisions. More emphasis should be placed on published reports in peer-reviewed journals because it would strengthen support for decisions.

Response: The Service agrees that published or peer reviewed material should be used whenever possible. Many times, however, the Service must use unpublished reports because they are often the only or best sources of information on rare species.

It should be noted that reports or articles can be peer reviewed whether or not they are published in an academic journal. All reports produced under contract with the Service have been reviewed by at least one Service biologist and sometimes more than one. Some unpublished reports have been peer reviewed by the academic community. Reichenbacher (1993) is an example of a unpublished report reviewed by academic peers.

Comment: The average rainfall for the Bylas area should be derived by combining the average rainfall of Fort Thomas with that of San Carlos. Bylas lies between these two sites.

Response: The Service believes it would be in erroneous to average precipitation records from two collection points. Precipitation in Arizona is very localized, particularly during the summer. Instead, the recovery plan has been amended to include the precipitation data from both Fort Thomas and San Carlos.

Comment: The recovery plan recommends avoiding land exchanges that will transfer *P. subintegra* populations out of Federal ownership and into private or State ownership. Is potential habitat also included in this statement?

Response: The Service is presuming that land exchanges involving potential but unsurveyed habitat on Federal lands will be surveyed for *P. subintegra* before land exchanges are proposed or finalized. Such surveys are required by Forest Service policy. Federal land that formerly supported *P. subintegra* plants but is now degraded should not be exchanged into private or State ownership.

Comment: The statement that Arizona cliffrose is capable of high reproductive output seems to contradict the statement that "age at first reproduction is unknown as is the average or maximum longevity of plants."

Response: The Service believes these two statements are correct and do not contradict. The average number of reproductive years is a different parameter than the number of seeds produced per plant per growing season. Both parameters are needed to construct a life table for the species. Wording in the text has been changed to clarify the concept.

Comment: The discussion of evolutionary history should be changed to reflect the following scenario:

The Arizona cliffrose was more widespread in the mid-Tertiary pine-oak juniper woodlands of the southwest during the more equable climates then. Subsequent geomorphological changes resulting in rainshadows and lower elevations with climatic deterioration have shrunk its habitat in the present.

Response: Any discussion of the distribution of Arizona cliffrose during the mid-Tertiary (25-35 million years ago) would be speculative and irrelevant to the

current status of the species. Arizona cliffrose may not have even evolved as a species until well after the mid-Tertiary.

Comment: We suggest rewording the fifth item of recovery criteria 2 to read as follows: Any vehicular access not on designated roads is prohibited within the four recovery units and designations effectively remove or minimize traffic off designated roads.

Response: Wording in the recovery plan has been modified somewhat following this comment. The recommended language was not quoted verbatim because the Service believes removal of vehicular traffic on specified roads and jeep trails that occur within Arizona cliffrose habitat may be necessary to recover the species.

Comment: Because we believe adequate protection from grazing is given to all subpopulations of Arizona cliffrose in the Burro Creek area, it is not necessary to expand the ACEC to include all subpopulations. Redefining the ACEC would require a RMP amendment.

Response: In the draft and final recovery plan, the Service has identified a number of threats to the Burro Creek population. Grazing is only one of those threats. Extending the boundaries of the proposed ACEC to include the other subpopulations would increase the protection from mining, the major threat to this population, and from other threats, such as a pipeline that is currently proposed. The Service believes that expanding the ACEC boundary is important to recover the Arizona cliffrose.

Comment: The lengthy discussions of *Purshia stansburiana* in the draft recovery plan are superfluous to the management and survival of *Purshia subintegra*. The inclusion of such discussions in the recovery plan is questionable.

Response: *Purshia stansburiana* is mentioned in the recovery plan because its relationship to *Purshia subintegra* has been a focus of discussion for many years. The Service believes a summary of past and present hypotheses related to this issue will help refocus the discussion and move recovery forward.

Comment: What studies have been done to show that Arizona cliffrose is long-lived?

Response: Arizona cliffrose is a woody perennial. Large, presumably older individuals have a thick mainstem, indicating age. No studies have been done

that quantify the subjective term "long-lived," it is believed the term is used accurately.

Comment: Arizona cliffrose plants have long tap roots and have never been successfully dug up and transplanted, despite what some roadbuilders would like to believe.

Response: Arizona cliffrose plants probably do have long tap roots, although their length has never been measured. To the knowledge of the Service, no attempts have been made to transplant Arizona cliffrose, so transplantation success is unknown. Other woody perennials with long taproots (e.g. mesquite and foothills paloverde) are now routinely transplanted with success, using special techniques and considerable effort. It is not known whether or not these methods could be successfully applied to transplanting Arizona cliffrose, but it is worth investigating (see recovery plan task 2e). The Service is not, however, recommending transplantation in lieu of habitat conservation and protection.

Comment: A very detailed description of the Arizona cliffrose population and habitat boundaries near Cottonwood is provided.

Response: The Service thanks the commentor for the detailed information, which can now be used by the Service and others when working in the Cottonwood area. However, we do not believe such specific information needs to be included in the recovery plan.

Comment: Some earlier, previously more widespread taxon of *Purshia* may be being "swamped out" by *Purshia stansburiana* in the Tonto Basin, but there is nothing to support the hypothesis that it was *Purshia subintegra*.

Response: The recovery plan clearly states that the Tonto Basin plants are *Purshia stansburiana*, not *P. subintegra*. However, the Service believes the preliminary data of Mount (1993) and Reichenbacher (1993) support the hypothesis that some gene mixing between the two species may have occurred in the past. Not all genes code for morphologic characters and therefore the results of gene mixing may not be expressed through morphological traits.

Comment: A conservation lease could be developed to protect Arizona cliffrose on Arizona State Trust land in the Cottonwood area. Another agency or organization would have to request the lease.

Response: A conservation lease on Arizona State Trust land would benefit Arizona cliffrose if it would remove or reduce uses that adversely affect Arizona cliffrose. Current permitted uses do not adversely affect the species. Future uses that are compatible with Arizona cliffrose recovery should be identified in the management plan recommended under task 1d of the recovery plan. A conservation lease is one option the State Land Department could consider using to accomplish recovery goals.

Comment: The Coconino National Forest has proposed to keep the shooting range, which is causing habitat degradation. This should be identified as a threat.

Response: The Coconino National Forest may have considered keeping the shooting range in the past, but this is no longer their preferred action.

Comment: The State has been more effectual in protecting Arizona cliffrose and its habitat than the Coconino National Forest, despite the fact that the State law is weaker than Federal law. For this reason, Federal ownership would not be in the best interest of Arizona cliffrose.

Response: The State Land Department is required to maximize the economic gain from State Trust land. The current economic use of State Trust land containing Arizona cliffrose populations is livestock grazing. The State Land Department, Coconino National Forest, and the livestock operator have been recently cooperating conserve Arizona cliffrose. The State Land Department has also effectively controlled illegal off-road vehicle use. Given current land uses, threats to the Arizona cliffrose on State lands have been controlled. If land uses change and/or the State Trust land becomes privately owned, however, Federal ownership may provide the most protection. For that reason, Federal ownership is preferred.

Comment: Arizona State Parks Department is planning a large campground and horse stables for a newly acquired Natural Area and is also planning a system of horse trails leading from there into the Verde Valley Botanical Area, Coconino National Forest.

Response: The Arizona State Parks Department can implement such a plan on State Park land if it is in compliance with State laws. The recovery plan does not regulate such plans but does recommend that no new recreational trails be added through habitat (task 3d.1). If the Coconino National Forest proposes to construct horse trails through the Verde Valley Botanical Area and the proposed action may affect Arizona cliffrose, the Coconino National Forest must undergo section 7 consultation with the Service. The outcome of consultation would

determine if trail construction would or would not be likely to jeopardize the continued existence of Arizona cliffrose.

Comment: The Arizona cliffrose recovery plan is not an appropriate forum for speculative evolutionary hypotheses. Government agencies are not in the best position to make objective and accurate taxonomic decisions.

Response: The Service is required under the Endangered Species Act to protect Arizona cliffrose. This, by necessity, requires that the Service make taxonomic decisions about the identity of Arizona cliffrose plants. To make the best decisions possible about Arizona cliffrose, the Service has funded taxonomic research, sought advice and critical review from taxonomic experts, and used the expertise of Service personnel trained in systematic biology. Decisions on Arizona cliffrose taxonomy presented in the recovery plan are based on the Service's evaluation of presently available information. This does not imply that research should end or that interpretations might not change with new information. As new information is gathered, new recovery tasks may be identified, current recovery tasks may become unnecessary, and concepts of evolutionary history may change. Management decisions will employ new information as it becomes available and the Service will revise the recovery plan as necessary.

Uncertainty and disagreement about the taxonomic status of Arizona cliffrose existed for many years and delayed the recovery program. The Service believes that discussing old hypotheses and clarifying the species' description, range, and distribution in this recovery plan will help provide new momentum to the recovery program.

Comment: Used accurately, the word "hybrid swarm" refers to highly variable populations containing individuals similar to both parents and other individuals exhibiting a bewildering recombination of characters from both parent species. The draft recovery plan incorrectly applies the term "hybrid swarm."

Response: A hybrid swarm is a population of interspecific or interracial hybrids and their segregates and intercrossed derivatives (Radford *et al.* 1974). An ancient, stabilized hybrid swarm would most likely not have a bewildering recombination of characters expected by the commentor (see following comment). The Service believes the recovery plan correctly applies the term hybrid swarm and therefore have retained it.

Comment: Lack of variability within Tonto-style populations indicates these populations do not fit the description of hybrid swarms.

Response: Hybrid swarms express an amount of morphological variability that is, in part, a function of time and generations passed since the original hybridization event(s) took place. One would expect that an ancient hybrid swarm that has been isolated from the parental stock would be less variable than a collection of first generation hybrids and backcrosses. Therefore, the lack of variability within Tonto-style populations is not in itself sufficient evidence to conclude that these are not hybrid swarms.

Comment: A new, expanded definition of *Purshia subintegra* is not needed, as suggested by the draft recovery plan. A return to the original, accurate description will suffice.

Response: The suggestion that the definition of the taxon be broadened has been removed, but the Service continues to believe that clarifying the definition would be helpful.

Comment: It is invalid to use Schaak's discredited interpretation of *Purshia pinkavae* to explain variability of morphs among and within populations.

Response: The recovery plan states that Schaak's hypothesis and field interpretations were not widely accepted by the botanical community. The intent was not to use the term to explain morphological variability, but to ensure that all opinions expressed in the literature were considered when preparing the recovery plan.

Comment: Speculations about the evolutionary history of *Purshia subintegra* have been mostly conceptual rather than tangible, have often been wrong, and don't directly relate to recovery.

Response: Evolutionary histories are always speculative and conceptual and never tangible because we can not go back in time to verify them. Some of the hypotheses regarding the evolutionary history of Arizona cliffrose are now believed to be in error, but their proposal and subsequent evaluation is important to the scientific process of testing and discovery. It is possible that some hypotheses have slowed or altered the protection and recovery of Arizona cliffrose, as the commentator has noted elsewhere. If so, hypotheses regarding Arizona cliffrose evolutionary history are directly related to recovery.

Comment: The Cottonwood population may contain 80% of all known Arizona cliffrose plants on the planet.

Response: The Service believes there is insufficient data to support the statement, particularly since little is known about the Bylas population.

Comment: Hypanthium plus pedicel length for Verde Valley form plants is within the range of the common form of *Purshia stansburiana* and should not be used as a distinguishing factor.

Response: While it may not be a distinguishing factor, it is a somewhat useful factor and its inclusion in table 1 does no harm. The word "distinguishing" has been removed from the text to avoid confusing the term "distinguishing character" with "diagnostic character."

Comment: Terrain, accessibility, and distance from urban areas are the primary reasons for little or no off-road vehicle use in Arizona cliffrose habitat near Horseshoe Lake.

Response: The Service agrees that rough terrain may explain why current off-road vehicle traffic is negligible and have modified the text accordingly. However, dirt roads provide fairly easy off-road vehicle access to both the subpopulation at Chalk Mountain and the one near the dam. All sites are within easy travelling distance of more than 2.5 million inhabitants of the Phoenix basin.

Comment: Is there a demand for Arizona bentonite? Bentonite mining is a threat to some Texas plants.

Response: The Service does not know if there is a demand in general for Arizona bentonite.

Comment: What population sizes are necessary to maintain a reasonable level of genetic diversity?

Response: The results of Mount (1993) are preliminary indications that genetic diversity is not currently a factor limiting population survival. The Service does not believe it is prudent to reduce the size of a population so low that genetic diversity becomes critical to survival. By conserving, protecting, and recovering the four populations, we do not anticipate approaching the minimum size necessary to maintain genetic diversity. By collecting demographic data on the

four populations, we may begin to understand the recruitment, survivorship, and mortality rates needed to maintain viable populations.

Comment: There is no reason to presume the Bylas population is unhealthy and appears to be the largest population of the four. What does it need to be recovered from?

Response: Recovery plans not only recommend ways to recover species from threats that have existed in the past, they also recommend ways to prevent other known threats. The recovery plan makes no presumptions about the health of the Bylas population but does report available information and suggests ways to prevent future adverse effects.

Comment: The plan should differentiate between different types of off-road vehicles. Specifically, mountain bikes may not pose a threat to Arizona cliffrose.

Response: The Service believes that all types of off-road vehicles should be prevented from travelling in Arizona cliffrose habitat. Mountain bikes disturb soil and soil organisms and can kill young Arizona cliffrose plants.

Comment: A discussion of the parameters necessary to maintain viable populations should precede the research recommendations.

Response: Such a discussion would be helpful but lengthy and the Service believes it is readily available in textbooks and other scholarly publications.

Comment: It is not practical to designate a special management area on the Tonto National Forest for the Horseshoe Lake population of *P. subintegra* because the subpopulations are separated by unsuitable habitat.

Response: The separation of subpopulations by unsuitable habitat does not eliminate the need nor does it necessarily make it impractical to designate a special management area. The Forest Service has the option of designating three small areas, each containing an Arizona cliffrose subpopulation, as special management areas, possibly as botanical areas. Areas smaller than 160 acres can be designated (Forest Service Manual 2372.04c). Alternatively, the Forest Service could choose to designate one special management area near Horseshoe Lake. The designated area could include the habitats containing Arizona cliffrose as well as other rare plants, such as *Eriogonum ripleyi*. The special management area could be designated to not only protect Arizona cliffrose but also the unusual plant community.

Comment: Designating a special management area on the Tonto National Forest for the Horseshoe Lake population of *P. subintegra* will not provide more protection to the species. Specifically, such a designation will not provide added protection from mineral exploration and development because operators will have to comply with the Endangered Species Act.

Response: Special management areas can provide more protection and management priority over that generally prescribed by the general land management plan or the jeopardy standard provided by section 7 of the Endangered Species Act. Whether or not a special management area provides greater protection depends on the management prescription defined by the designating agency. The management prescription and actions taken by the Coconino National Forest support our conclusion that special management area designation can and does make a difference. If the Tonto National Forest chose to designate a special management area for Arizona cliffrose or for the limestone plant community, it could choose to prescribe the management actions and protections needed to achieve recovery.

The only legal standard currently protecting Arizona cliffrose on the Tonto National Forest is the section 7 jeopardy threshold. Mineral exploration and development having adverse effects to Arizona cliffrose could occur and still be in compliance with the Endangered Species Act if the Service determines the action is not likely to jeopardize the species. Small projects with adverse effects could accumulate and permanently impair species recovery. An example of cumulative habitat loss without jeopardy is the mineral exploration that has occurred in the Arizona cliffrose population at Burro Creek. The recovery plan recommends preventing these types of adverse effects through a number of methods, including special management area designations, management prescriptions, and mineral withdrawals. The Service believes that special management areas are the best way of setting management direction and achieving the desired result of recovery.

Comment: Why does the Service believe that recovery depends on the Bylas population? No information was presented.

Response: The Service can not justify reclassifying or delisting Arizona cliffrose with fewer populations than when it was listed. Therefore, recovery depends on the maintenance of the Bylas population, as is indicated in the recovery criteria.

Comment: The statement that a Mining Plan of Operations (MPO) is required only for projects larger than 5 acres is incorrect on National Forest lands. Forest Service regulations require a MPO on any mining operation regardless of the acreage.

Response: The recovery plan has been modified to reflect the Forest Service regulations (36 CFR § 228) for surface management of National Forest lands in connection with operations authorized by the U.S. mining laws (30 U.S.C. 21-54). These regulations pertain to locatable minerals and define the requirements for filing a notice of intent or MPO when an operator proposes to disturb the surface. A MPO is required only when the District Ranger determines that the proposed operations "will likely cause significant disturbance of surface resources" [36 CFR § 228.4(a)]. The latter regulation appears to conflict with the commentor's statement that Forest Service regulations require a MPO on any mining operation regardless of the acreage.

Comment: We believe the recovery plan should define "significant upward trend towards viability" and define what is needed to ensure the viability of each recovery unit. Without measures of "viability" and "significant upward trend" expressed in the criteria, there can be no monitoring undertaken to show when the objectives in this criterion have been met.

Response: Viability is well defined in the scientific literature. The demographic data needed to determine whether or not a population is viable is also well defined in the scientific literature. The Arizona cliffrose recovery plan is not a forum for presenting standard scientific methodologies. However, the recovery plan recommends the collection and analysis of this data (see task 2c).

Comment: Reference to the unique distribution of the species should be removed because all species have unique distributions. The same is true of the reference to the unique biological/ecological characteristics and threats of each Arizona cliffrose population.

Response: The Service agrees that all species, including Arizona cliffrose, have unique distributions, characteristics, and threats. For that reason, the more descriptive wording is retained.

Comment: Just because each of the four *P. subintegra* sites support unique assemblages of plants does not mean it is important to preserve all four populations.

Response: As stated in the recovery plan text, the Service believes the remaining range of genetic and community diversity is needed to recover Arizona

cliffrose and preserve the ecosystems upon which this species depends. Preserving biological diversity is a founding concept of the Endangered Species Act. The unique assemblages of plants at each site is one of several factors that support our recommendation to conserve and recover all four populations. The other factors are stated in the recovery plan.

Comment: The grazing history of the Horseshoe Lake population needs to be clarified. Within which grazing allotment(s) does *P. subintegra* occur and does livestock grazing occur there now?

Response: The confusion regarding the management of livestock at the Horseshoe Lake localities has been reconciled. The text has been altered to correctly describe grazing management.

Comment: The BLM believes recovery criteria must be measurable and specific. Recovery criteria must be readily interpreted such that monitoring or other simple recordkeeping can be used, along with the criteria, to determine whether or not they have been met. Criteria as stated in the draft could arguably never be met, depending on the interpreter.

Response: The Service believes the recommended downlisting criteria are measurable and specific. The demographic parameters needed to meet downlisting criteria #1 can be measured and used to determine if the populations are viable. The specific requirements for meeting downlisting criterion #2 are provided. Downlisting criteria #3 and 4 are self explanatory. The Service has tried to minimize the subjectivity inherent in these decisions, but believes some subjectivity is inescapable.

Comment: The standard that utilization of Arizona cliffrose should not exceed 20% should be re-evaluated. Use levels that have occurred outside of livestock grazing allotments have shown that wildlife use alone exceeds 20% (page 34 of the draft recovery plan). The utilization standard should be an average utilization for the population based on criteria that meet conservation and recovery objectives. A maximum utilization amount for individual plants might be desirable.

Response: The recovery plan has been amended and recommends that livestock grazing be permitted in pastures containing Arizona cliffrose if combined use by livestock and wildlife does not exceed 20% of current year's growth for any individual. If livestock grazing will cause total utilization to exceed 20%, then it should not be permitted.

Page 34 of the draft recovery plan does not state that wildlife utilization of Arizona cliffrose can be much higher than 20%. It states that 65% utilization of Arizona cliffrose occurred in an area being browsed by wildlife, burros, and cattle. When burros and cattle were subsequently excluded from the same area, utilization dropped to 16-18%, which is presumed to be consumption by wildlife.

Comment: The utilization standard (recovery task 3b.1) should be flexible enough such that management actions can be readily taken to alleviate the potential for adverse impacts to occur.

Response: The meaning of this comment is not clear. The Service believes that the 20% utilization standard is needed to conserve and protect Arizona cliffrose. Management decisions regarding livestock stocking rates and grazing management systems should be flexible enough to accommodate the utilization standard.

Comment: The grazing prescription recommended by the recovery plan is overly restrictive. More flexibility could allow combinations of season of use, duration, frequency, and percent utilization.

Response: During the 10 years Arizona cliffrose has been listed, the Federal land management agencies have had the flexibility to apply the grazing system of their choice. Monitoring data and management priorities have contributed to the decisions to exclude livestock from one Arizona cliffrose population occurring on Federal land and part of another. The recovery plan is recommending standards that have been set and successfully implemented by Federal agencies. Therefore, the Service does not believe the recommended grazing prescription is too restrictive.

Comment: Arizona cliffrose evolved under light to moderate grazing by wildlife. The amount of utilization is more critical than total exclusion of grazing, which would never occur.

Response: The Service agrees with the hypothesis that Arizona cliffrose evolved under some wildlife grazing pressure. The recovery plan addresses the grazing pressure added to wildlife grazing by cattle, under which Arizona cliffrose did not evolve. It also addresses utilization by wildlife populations, which in modern times can be unregulated for several reasons, including the lack of or reduced levels of predators.

The recovery plan does not require total exclusion of wildlife nor cattle. It recommends total utilization by wildlife and livestock not exceed 20%. If that standard is exceeded, the recovery plan recommends livestock grazing be limited to a level that would not 20% utilization of forage available.

Comment: The Forest Service condition classes are different from BLM condition classes. The recovery plan should recognize the differences and clarify the text.

Response: The recovery plan has been revised and refers to potential natural condition instead of condition classes.